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DROP-FORGE DIE-SINKING*—1

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THE art of drop forging has worked a great change in the product of the blacksmith shop, both in regard to the quality and the quantity of the work produced. It has created a new branch of the business, and has enabled forgings to be employed in thousands of cases where this had formerly been impossible on account of the expense. Drop forgings are made today for nearly every branch of metal manufacturing, although the automobile industry has given rise to a much greater demand for drop forgings than has any one other industry. Drop forgings are made that weigh but a fraction of an ounce, and others that weigh a hundred pounds or over. They are made from iron, steel, copper and bronze. It is needless to speak of the advantages of the operation of drop forging; economy of manufacture, strength, interchangeability, and the general appearance of the product, are all important factors.

The object of this article is not, however, to deal with the drop forging operation itself, but to treat of the dies for this interesting work, and to consider some of the methods and tools used in the die-sinking. The good die-sinker must be somewhat of a composite mechanic: he must have the knowledge of machine work of the machinist; the skill of the ornamental die-sinker, for sinking the irregular impressions; and a knowledge of steel working so as to know just how the hot steel will flow under the dies. The majority of the drop-forge die-sinkers of today have emanated from the ranks of the machinists and tool-makers, but the die-sinkers of tomorrow will be specialists whose thorough training has been acquired entirely in this one important class of work.

Fig. 1. A Group of Untrimmed Forgings

Classes of Drop-forging Dies

Drop-forging dies, like dies for the punch-press, are of several different types. Perhaps the most simple form of drop-forging die would be a pair of dies for producing a simple round forging, as, for instance, a gear blank. These dies would require a central impression turned in each of the dies of the pair. Before using the dies, a square plate of steel is worked under the hammer, drawing out a short shank at the side, and "knocking down" the corners. This roughly shaped block of steel is held by the shank and placed between the dies and thus brought to shape.

The most common form of drop-forging die, however, is the one in which there is a central impression to shape the forging, and a side impression, called the "edger," "break-down" or "side-cut," that helps to properly distribute the hot steel. To make the use of these two sets of impressions clear, a drop-forging die of this description may be likened to a drawing of the finished forging, in which the outline of the central impression would resemble the plan view of the forging, and the two halves of the edger would correspond to the side elevation of the forging. Of course this illustration is not literally correct, but it expresses the general idea. The edger is always on the right-hand side of the die, and the steel bar is struck first in the break-down, edgewise, and then turned and struck flat in the impression, alternating in this manner until the forging is "full."

There are also dies that in addition to the central impres-

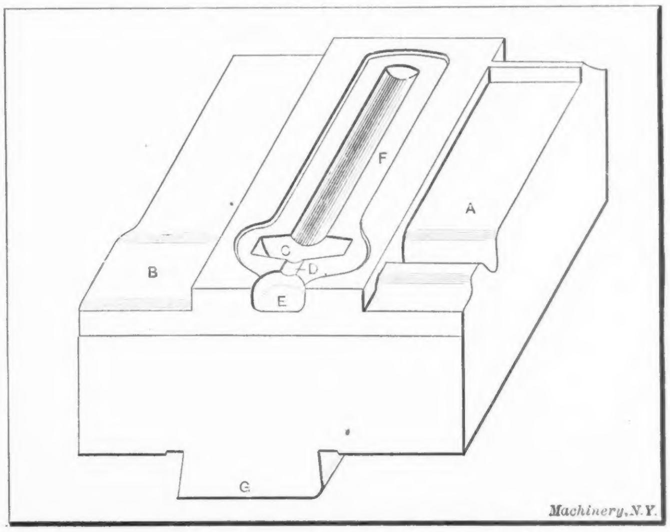

Fig. 2. The Lower Die of a Pair of Drop-forging Dies

Fig. 3. A Number of Small Finished Drop Forgings

* The following articles, dealing with this and kindred subjects, have previously been published in MACHINERY: September, 1908, "Drop Forge Work in an Automobile Shop"; May, 1908, "Drop and Stamped Forgings"; April, 1907, engineering edition, "The Drop Forge and Hardening Plant"; January, 1905, "Making Drop Forging Dies." See also MACHINERY'S Reference Series No. 45, "Drop Forging."

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sion and the edger are made with an anvil or "fuller," as it is sometimes termed. The anvil is formed in the dies at the left-hand side, and is used to draw out the stock previous to striking it in the edger or in the impression itself. Dies with anvils are necessary in making forgings in which there is a considerable displacement of the stock. As an example may be mentioned a double-ended wrench, which is thin in some places and very much thicker and wider in other places. The anvil consists of two flat-faced parts of the die, whose faces, called "fullers," come just near enough together to flatten the stock to such dimensions that when finished in the central impression very little stock will be left to be squeezed out as the fin. After the stock has been thus drawn out to roughly fit the impression, the forging is shaped in the usual way by means of the edger and the die impressions. A considerable number of large drop-forging dies require anvils. In making the dies for difficult forgings, there are often other special features incorporated in the dies, which will be more fully described later.

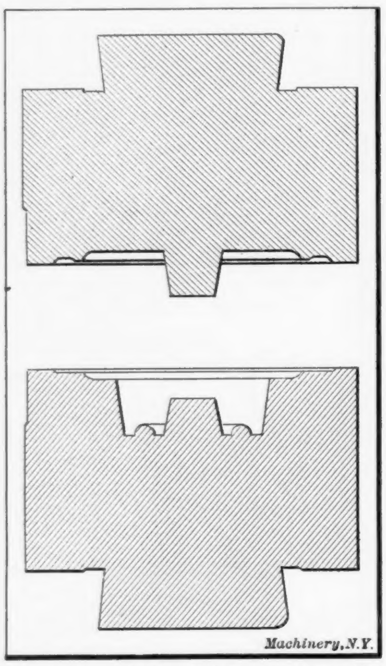

Fig. 4. Drop-forging Dies of a Type that should be made of a High-carbon Steel and not hardened

Fig. 2 shows the lower half of a set of dies with a breakdown *A*, an anvil *B*, and the die impression *C*. The sprue is shown at *D*, the gate at *E*, the flash at *F*, and the shank at *G*. In Fig. 1 are shown several completed forgings before being trimmed. The center of the eye-bolt is the only part that has been trimmed. The excess metal around the forging is called the "fin" and is removed in a separate operation, which may be done either hot or cold. If the forgings are to be cold-trimmed, as is the case with most small forgings, the dies are made with a cut-off to sever the forging from the bar when finished. If the forgings are to be hot-trimmed, they are severed in the trimming press, and the forging dies will need no cut-off. Fig. 3 shows a group of small finished forgings.

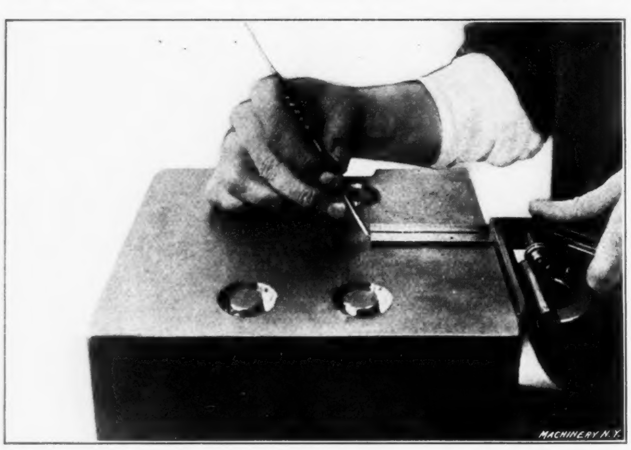

Fig. 5. Laying out the Dies: Transferring a Line from One Die to the Other of a Pair

Thus far we have considered only dies with one impression, but in dies for first-class forgings, especially when there is a large number to be made, two impressions are provided, the forming and the finishing. The forging is nearly completed by the edger and the forming impression (and anvil if needed), and finally struck several blows in the finishing impression to bring it up to size and finish it. Thus the finishing impression is saved the severe duty of completely forming the forging, and hence the dies last longer. On small and medium-sized forgings these two impressions are placed side by side in the same die, but if the forging is large, the finishing impression is made in a separate set of die-blocks and set up in a hammer beside the dies that form the forging. The forger uses both hammers to get out the work in such cases. It is seldom that more than two impressions are cut in the same set of dies, but if the piece is small and the number of pieces to be forged great, it is often advisable to make the set of dies with two or more finishing impressions in addition to the forming impression. If this is done, the die has a longer life, for after one of the finishing impressions gives out by spreading or "checking," there is still a good finishing impression left.

In addition to these different styles of drop-forging dies, the dies for trimming the fin from the forging must be taken into consideration. As already indicated, trimming dies are of two classes: those for trimming the forging while it is hot, and those for trimming the forging after it is cold. The making of drop-forging dies for forgings of other metals than steel or iron involves the use of special methods. This phase of the subject will be treated later in this series of articles.

Information Required by the Die-sinker

Before the die-sinker begins making the die, he should be given certain information about the job he is to do, in order to make a set of dies that will give satisfactory results. As a general rule, he is furnished with either a drawing or a model of the finished part, or, what is most satisfactory of all, with a sample forging. He must know what finishing operations the forging is to pass through, so as to allow enough stock for machining, and he must know of what metal the piece is to be made, so as to cut the dies large enough to allow for the shrinkage of the metal.

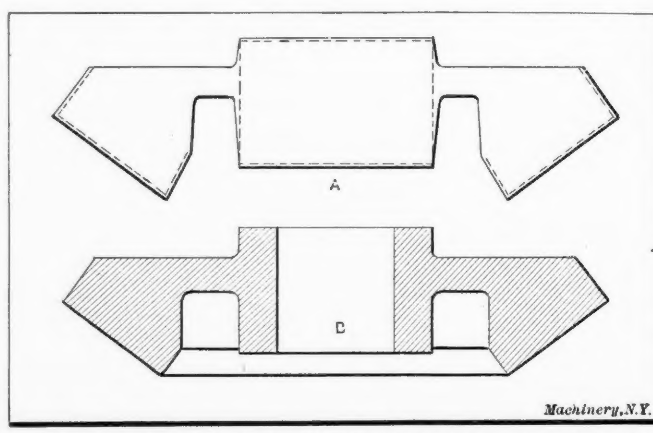

Fig. 6. Templet with Shrinkage, Draft and Finish Allowances added, used in turning out the Impression in a Die for a Bevel Gear Blank. B shows the Finished Gear Forging after being machined

With this information supplied, he must decide upon some other points that are largely a matter of judgment on his part—points that have to do with the successful working of the dies. He must decide, first, whether to make the set of dies with a forming impression in addition to the finishing impression; second, the way in which to "face" the impression on the die-block, so as to be able to use the best form of edger; third, whether to include an anvil in the dies; and fourth, the type of hammer or hammers the dies will be used in, so that the dies are made in blocks of the proper size. In making the trimming dies, he must also decide whether to trim the forging hot or cold. With these points decided, he is prepared to start the making of the dies.

Steel for Drop-forging Dies

Open-hearth crucible steel is the material from which nine-tenths of all drop-forging dies are made; a 60-point carbon steel is used for most of the dies. In some cases, however, steel as low as 40-point carbon and as high as 85-point carbon is used, but few shops use anything but 60-point carbon steel for the general run of work. If a low-carbon steel is used, a special hardening treatment is required, which outweighs

any saving in the price of the steel. Of course, the high-carbon steels make good dies, but except in special cases, there is no necessity for using so high-priced a steel. The average 60-point carbon steel die, if properly hardened, should last for from 15,000 to 40,000 forgings, and sometimes as many as 70,000 forgings are made from one set of dies.

In making dies for large forgings, it is often considered advisable to use 80-point carbon steel for the dies, and not to harden them. This obviates the danger from "checking" or cracking in hardening, and the steel, unhardened, is hard enough to resist the tendency to stretch. In Fig. 4 is shown, in cross-section, a pair of drop-forging dies for forging automobile hubs. Dies of this design should be made of high-carbon steel and left soft, on account of the projecting ring in the bottom of the impression which would be very apt to break off if the die were hardened. A steel fairly high in carbon should always be employed for dies that are to be used for making forgings from tool steel or other hard steel. When making forgings for very thin parts that cool quickly while being forged, it is usually preferable to use tool steel for the dies, in order that they may be hardened to a depth sufficient to withstand the tendency of the dies to "dish." A drop-forging die or any die used in the drop hammer, is said to be "dished" when the force of the blows it receives causes the central part of the face to sink beneath the level of the remainder of the face. This condition results in forgings or stampings that are too thick in their central parts. Dishing is usually traceable to a low grade of steel or to improper hardening.

Preparation of the Stock

The best method of preparing the die-blocks is to plane the stock in lengths of from six to eight feet, after which it may be cut to any lengths required by the sizes and shapes of the forgings for which the dies are being made. Occasionally a pair of die-blocks must be planed for a special job, but it is quicker and cheaper to plane them in lengths when the work warrants it, although many shops do not take advantage of this. The steel may be obtained from the mills in ordinary sections suitable for dies six or eight inches in height, which are the sizes mostly used. At the time of planing, the dies are "shanked" with the proper bevel and height of shank, to agree with the system in vogue in the shop where the dies are to be used.

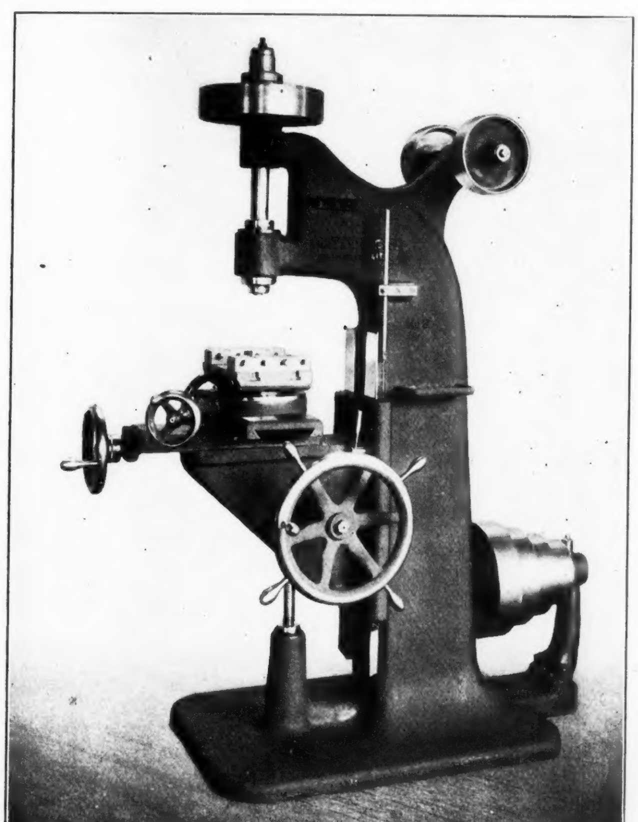

Fig. 7. The Pratt & Whitney No. 2 Die-sinking Machine

The die-blocks are planed on the front and left-hand sides for a distance of two inches or a little less from the face. These two cuts are merely "skin chips," and are perfectly square with each other and with the shank of the die; their purpose is to furnish faces from which the impressions may be laid out. The use of these "matching-sides" is plainly indicated in Fig. 5. The reason for using the left side is because the edger is always to the right, and in cutting away for this part of the die, the lay-out face would be destroyed. This would make it impossible to work from that side afterwards, in case it should be necessary to make changes in the impression. On the left side the anvil is formed, but this interferes but little with the working face that has been planed, because the anvil occupies but little space, at least as regards depth. In planing these working faces, care must be exercised to have the faces perfectly parallel with the shanks of the dies; otherwise the two halves of the forging will appear to be twisted with relation to each other, and to correct the error it will be necessary to "shim" the dies—a practice that should be permitted only as a last resort.

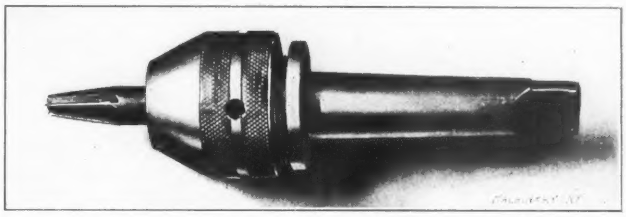

Fig. 8. Special Cutter Chuck for the Die-sinking Machine

There are various precautions taken to prevent blunders in the setting up of the dies. The forger usually lines up the dies by matching the sides of the die-blocks. On dies whose matching faces have been cut away, the die-sinker usually cuts a deep "nick" from one die to the other, while they are in alignment. The shank of the upper die-block is milled with a "half-hole" to fit the familiar "dutchman" in the hammer of the drop-press.

Laying Out the Dies

We are now ready to take up the work of laying out and cutting the impressions in the dies. The laying-out of drop-forging dies is totally different from the laying-out of blanking dies, this being due principally to the different allowances that must be made for shrinkage, draft and finish. The allowance for shrinkage is an important one. In order to properly understand the considerations to be taken into account, it is necessary to understand the trimming methods employed for removing the fin. Small forgings are invariably completed, and the fin trimmed off after they are cold; such forgings are said to be cold-trimmed. Larger forgings are trimmed hot and then struck once or twice to finish and straighten them, as it is probable that the trimming has somewhat distorted them. At the time of the last blow, the forging has cooled to a low red heat. In making dies for small cold-trimmed steel forgings, the proper allowance for shrinkage is 3/16 inch to the foot or 0.015 inch to the inch. Such forgings are completed at a bright red heat, and the rate of shrinkage is great.

In making dies for hot-trimmed steel forgings, which are of medium and large size, the proper allowance for shrinkage is 1/8 inch to the foot or 0.010 inch to the inch. Hot-trimmed forgings, receiving the finishing blow while relatively cold, shrink a smaller amount than forgings that are cold-trimmed. These proportions hold true for all dimensions of the die impression, whether they be depth, width or length. In making dies for forging bronze or copper, the same principles apply, and the rate of shrinkage for cold-trimmed forgings is 3/16 inch to the foot, and for hot-trimmed forgings 1/8 inch to the foot, or practically the same as for steel.

The Draft Allowance

It would be very convenient if we could sink forging dies with sides perfectly straight, the same as a die-casting mold, but in die-sinking this is impossible, as the forging would stick in the die. To overcome this tendency, we employ "draft," just as the patternmaker does. The amount of draft

given a drop-forging die varies from 3 degrees to 10 degrees. If the die is for a thin regular forging, like an oval treadle plate, 3 degrees is ample, but if the forging die is deep, with narrow ribs which are apt to stick, at least 7 degrees is necessary. Should the die be for forging a piece that is ring-shaped or has a ring in its make-up, the central plug that forms the interior of the ring will require a draft of 10 degrees, because, as the forging cools while being worked, it

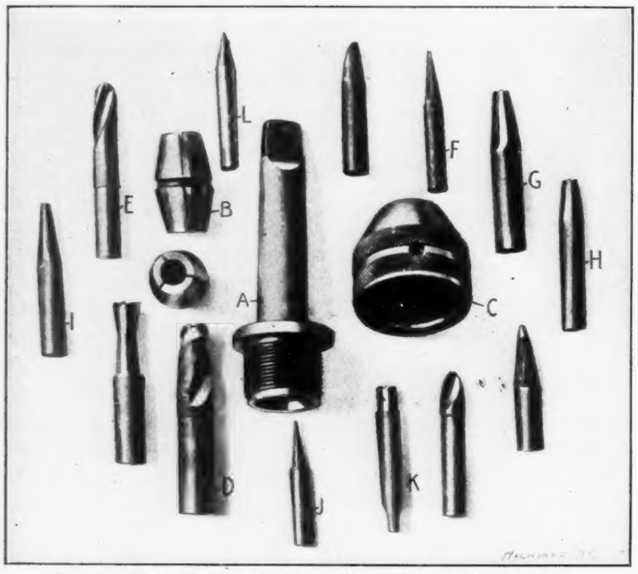

Fig. 9. Chuck Parts and Cutters for the Die-sinking Machine

tends to shrink together around the plug, and if the draft is insufficient, it will stick in the die. With the above exceptions, however, the majority of drop-forging dies are cut with a 7-degree draft. For convenience in laying out, it is well to remember that a 7-degree taper equals practically a ⅛-inch taper to the inch, and a 10-degree taper, 3/16-inch to the inch.

The Allowance for Finish

By "the allowance for finish" is meant the additional metal that is "put on" the forging at those places that are to be machined. Very often it happens that there is no finish required on the forging, in which case, of course, there will be no allowance. Usually, however, there are bosses to be faced off or other places that require machining, and in such cases the forging is left 1/32 inch oversize at these points.

Scribing the Outline

In laying out the dies, the first step is to copper the faces of both the upper and lower die, after which center lines should be scribed from the two matching-sides of the die-blocks. If the forging is irregular in outline, it is advisable to make a templet. Not only will the templet be useful in laying out the two impressions, but if the forging is to be hot-trimmed, the templet can be used in laying out the trimming die and punch. The use of a templet insures that the two dies will match perfectly, for after laying out the lower die, the templet is simply reversed and used for the upper die. The templet should be made of thin sheet metal, and if brass or zinc is used, it may be sawed out with a band or scroll saw and then filed to the line in the usual way. Fig. 6 shows at *A* a templet for a bevel gear forging, with the various allowances made, ready to be used in laying out the impression; *B* is the finished gear blank. First the outline of the finished forging is laid out, then the draft allowance is added, and at those points that must be machined, allowance is made on the templet for this purpose. In laying out the set of lines for the shrinkage allowance, a shrink-rule is used, either a ⅛ inch to the foot or a 3/16 inch to the foot, as the case may require.

Frequently it happens that the outline of the forging at the parting line is simple and regular, as, for instance, in the case of an eye-bolt forging. In the case of such a simple shape, there is no necessity for a face templet, as the outline may be laid out from the two matching-sides of the dies by means of a square and dividers. In order that the outlines of the impressions on the two blocks may come in perfect alignment, two and sometimes three combination squares are used in locating the templet on the blanks, in case a templet is used. The templet is placed in its proper position on the face of one of the die-blocks, and a combination square is set from each of the matching-sides to the edge of the templet. With the templet against the ends of the square blades, the outline is scribed; then, without changing the blades of the squares, they are placed in corresponding positions on the other die-block, thus locating the templet (now reversed), and the outline is scribed on this die. The combination square also affords a good way for transferring lines from one die to the other. Fig. 5 shows the die-sinker transferring a measurement from one die to the other die upon which he has started work. After the outlines of the two impressions are scribed on the faces of the die-blocks, they should be either lightly prick-punched at intervals along the lines, or they should be traced with a small, sharp chisel, using the chisel after the manner of a punch, and moving it after each tap of the hammer so as to obtain a clear, deep, continuous line.

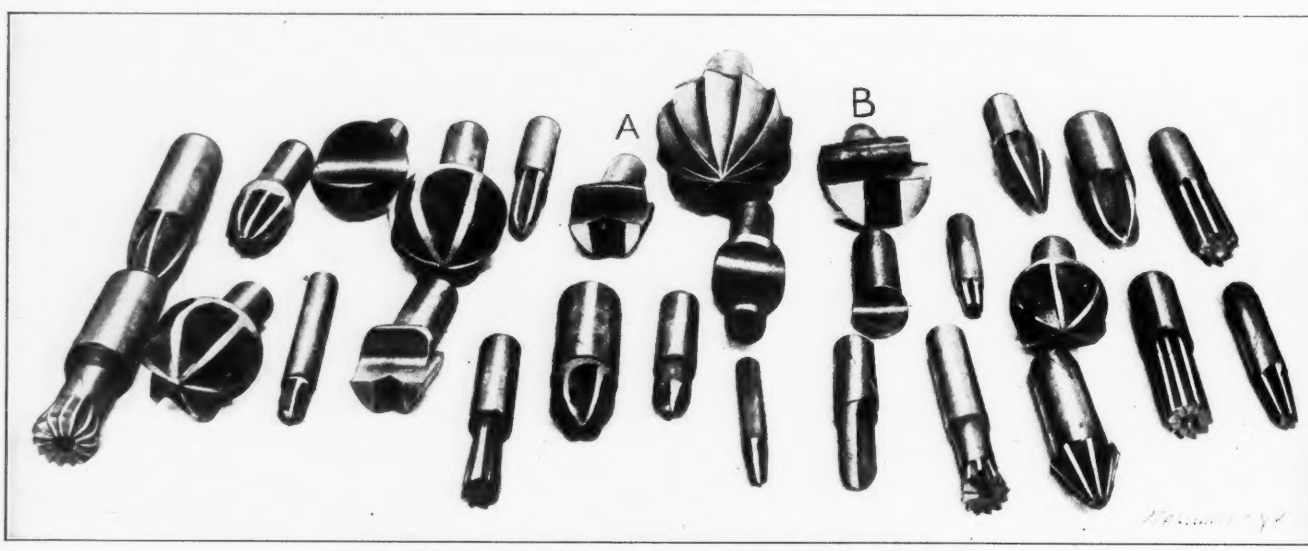

Fig. 10. Hub, Forming and Miscellaneous Cutters for the Die-sinking Machine

In planning the lay-out of a drop-forging die, there are several points that must not be overlooked. The heaviest end of the forging should always be at the front of the die-block, as illustrated in Fig. 2. This makes the forging easier to handle while being forged and still on the bar, and it also permits the use of a liberal-sized sprue. In selecting a die-block and laying out the impression, there should be at least 1½ inch left all around the impression from the outside edge of the block or from any part of the die, such as the edger, anvil or forming impression. If the forging has a hub or other projection that extends some distance from the body of the forging on one side, as in the illustration at the center of Fig. 3, the upper or top die should contain this deeper im-

pression. This is an important point, for every die-sinker and drop-forger knows that it is easier to "shoot" the metal up than down; just why it is so, however, is difficult to understand.

Sinking the Impression—The Machine Work

The work of sinking the impressions in the dies may be roughly divided into two parts: the machine work, and the hand work. In the machine work, the lathe and the vertical milling or die-sinking machine are the two principal machine tools used. Generally speaking, if there are parts of the impression that can be cut out on the lathe, it is good policy to do this work first, although there are exceptions to this rule which will be mentioned later. The advantage of doing the lathe work first lies in the fact that a large amount of the stock is removed quickly and uniformly, so that the die-sinker has a better chance to start the milling cutters.

The best method of holding the dies for the lathe work is by means of a special bolster, bolted to the faceplate. The bolster is planed to take the shank of the die-block, which is held in place by a key. This method has certain advantages over the practice of holding the die-block with set-screws, in that the block may be more easily made to run true, and there is less danger of the die-block working loose. Much time may be saved in the turning if the lathe is equipped with a compound rest, for the draft may then be bored out by swinging the rest over the required number of degrees. If the lathe work is other than very plain, it is necessary to make use of templets. In turning out the impression for a bevel gear blank, for instance, the templet for the turning would appear as shown at *A* in Fig. 6. A study of this templet will give a good idea of the allowances for draft, shrinkage and finish. The lines of the finished gear show a straight hub, that is, there is no bevel on its sides. In cutting the impression, however, these lines must be given a draft of 7 degrees to prevent the forging from sticking in the dies. The top and bottom of this hub, as well as the face where the teeth are to be cut, will of course be machined; therefore 1/32 inch is added to the templet at these places. The shrinkage allowance is taken care of by laying out the dimensions of the templet with the ⅛ inch to the foot shrink-rule, as the forging will be trimmed hot.

Fig. 11. Using the Circular Attachment

The Die-sinking Machine

The die-sinking machine is by far the most important asset of the die-sinker's equipment. At the present time, most die-sinking shops are equipped with machines of the Pratt & Whitney make—the No. 2 machine for the small and medium work and the No. 3 for the heavy work. These two machines will take care of any dies to be made, and in small shops where but one die-sinking machine is installed, the No. 2 size will be found sufficient, if the work is not very large. The illustration Fig. 7 shows the latest model of the No. 2 machine. The dies are held in the vise of the machine, the shank of the die-block furnishing a good gripping surface. The cutters are held in a spring chuck, that, by substituting different collets, will accommodate cutters made of stock from ¼ inch to 1 inch diameter. This chuck, shown in Fig. 8, and its parts in Fig. 9, is made in three pieces—the shank *A*, which is recessed to take the split collet *B*, and the sleeve *C*, which has an internal taper bearing surface. As the sleeve is screwed onto the shank, the split collet is compressed, drawing together upon the cutter without throwing it out of center. The sleeve is tightened by the aid of a spanner wrench, and no trouble is experienced from the cutter slipping in this style of chuck.

Cutters for Die-sinking

The subject of cutters for die-sinking is a very important one, for neither good nor fast work can be done with poor cutters. The very best of roughing cutters can be made from "stub ends" of Novo drills, and nearly every die-sinker takes advantage of this fact. These short drills are ground ball-pointed on the cutting end, given clearance, and the center ground out as shown at *D* and *E* in the illustration Fig. 9. This kind of cutter is so easily and quickly made, and stands up so well in "hogging out" the stock, that it does not pay to use any other kind.

For finishing, the cutters are made with three or more flutes, so as to get smooth surfaces. Finishing cutters must be provided in a large variety of shapes, to take care of the various forms in the dies being cut. At *F*, *G*, *H* and *I* in Fig. 9 are shown good examples of finishing cutters, most of which are made for finishing dies with a draft of 7 degrees; at *J* and *K* are shown special cutters, the former for cutting very narrow grooves, and the latter for shallow dies with a draft of 2 degrees.

The die-sinker is guided in the milling by the lines laid out on the face of the die-block and by the index on the pilot wheel of the die-sinking machine, the scribed lines giving the outline, and the index of the pilot wheel taking care of the depths of the various parts of the impression. Except when using special cutters like hub and forming cutters, no oil is used on the tools. The speeds at which the cutters should work vary with the size and style used. If the cutter is a small one, like that shown at *J*, Fig. 9, the speed may be much higher than would be used with a stout cutter like that shown at *G*. Of course, special forming cutters that are sometimes as large as 3 inches in diameter must run very much slower, and the use of lard oil is advisable. Fig. 10 illustrates some of these hub and forming cutters, and also shows a large variety of finishing cutters of various shapes and degrees of draft.

Fig. 12. Roughing out the Impression

All circular parts of the impression are not bored out in the lathe, and indeed it is rarely advisable to bore out any parts under 3 inches in diameter, especially if they are deep. These small circular depressions are best taken care of by special forming cutters or by the circular attachment on the die-sinking machine.

A great many forgings for machine parts have bosses in which must afterwards be drilled a central hole. It is not practical to forge the part with the hole, but it is a great help to "spot" the forging, and thus obviate the necessity for using a jig for the following operation of drilling the forgings. To produce the projection in the die for this "spot," a hub cutter is used. (See *A* and *B* in Fig. 10.) On account of being milled out at the center, and relieved, the cutter will leave a cone-shaped projection in the bottom of the impression

that will produce a deep countersink in the boss of the forging.

It is very essential that a large cutter should be correctly located in relation to the outline of the impression before being fed into the die. In order to check its location, it is well to scribe, from the same center, a circle one or two inches larger than the one that is used for obtaining the outline. On this outer circle, four points, equidistantly spaced, should be prick-punched. After lightly entering the cutter, the outline should be tested with dividers from these four points.

The Circular Attachment

The circular attachment on the die-sinking machine is a valuable feature in milling the impressions. By its use, much circular work may be done that would be awkward to bore out in the lathe, and short arcs may be cut far better and quicker than in any other way. In using, a straight pointed rod is held in the chuck in place of a cutter. The machine table is adjusted with the two feed handles until the indicating marks, placed on the sides for this purpose, are in line. The table is lowered and the die-block located in the vise so that the center point of the arc to be milled is directly under the indicator in the chuck. Thus located, the table may be moved off center far enough to bring the cutter to the part of the impression that is to be milled, and the line followed by using the feed provided. In Fig. 11, the die-sinker is cutting the impression for forming the eye of a chain hook, using the circular attachment in doing so. The old-style method of cutting these curves, used when the die-sinking machines were not equipped with circular attachments, was to loosen the check-nuts of the swivel vise, and after moving the die to the proper distance from the center, clamping a long steel bar to the vise, and rotating the vise by hand. This method is here mentioned for the benefit of those whose die-sinking equipment is not of modern design.

Throughout all the machine work on the impressions, it must be remembered that as little stock should be left to be taken out by hand as is possible, for not only is hand work slower, but its quality can never equal machine work that is properly done. To this end, the finishing cutters should be run over the last cut two or three times, so as to get the smoothest possible surfaces. The heavy milling should be done with the roughing cutter, held in the chuck close to the cutting point, after the manner illustrated in Fig. 12. If, after the finish milling, the surfaces are smooth and the line is "split," there will be little left to be done by hand save the corners and possibly a few irregular shapes that cannot be milled. In the final milling cut for finishing to correct depth, exact dimensions may be obtained by setting the cutter so that it just touches the surface of the die, and then moving the index on the pilot wheel to zero and raising the table to the required dimension, as indicated by the reading of the index.

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SOLDERING ALUMINUM

A new method of treating aluminum for soldering has been patented by L. Maitre of Predame, Switzerland. The aluminum is prepared for soldering by first depositing a thin layer of iron on the surface. It is then immediately immersed in boiling water and then in cold water. Next it is reheated until the deposit has acquired a blue color, when it is again immersed in cold water in the same manner as that employed in hardening steel. This treatment causes the iron deposit to adhere more strongly to the aluminum base. The film of blue oxide is now removed from the surface of the iron deposit by means of fine emery cloth, when the parts are ready for soldering. The soldering is accomplished by the ordinary method employed in soldering sheet steel or similar work.—*The Brass World.*

* * *

Trouble has sometimes been experienced in hardening high-speed steel tools in the chloride of barium bath, by the formation of drops of an exceedingly hard substance that cling to the steel. This substance is so hard that it can be ground off only with great difficulty, with emery or carborundum wheels. The trouble can be avoided by skimming off all scum or dross floating on top of the melted barium.

HALF A DAY IN AN OIL-COUNTRY SHOP

By V. J. M.

It was one of those first warm days in the springtime when a person feels lazy and the hum of machinery has a sleep-producing effect; these symptoms used to be known as "spring fever" before the advent of the more modern and up-to-date disease called "hookworm." (Speaking of hooks brings to mind that the fishing down at the canal is fine. Tor, our helper, was down after quitting time and caught some very nice suckers; one of them weighed—well, no matter how many pounds; it was good and big to hear him tell it!) We had just started in on a fairly long cut with an unusually fine feed, intending to slide into the tool-room and have a look at the Pittsburg papers which the cub gets, to see what Jeff and Mutt were up to, when along comes Billy, the boss. We knew by the way he handled his six-foot jointed rule that there was something doing.

"Say, Jim, I've got to go up to the brewery; Chris says the ammonia pump is 'busted' and you know what that means. Clem and Dick are both out on the Smith farm where the power house burned so you kind of keep an eye on things until I get back. Tell Brownie to be sure and lace the belts on the blower at the foundry, for Sam has a big heat to pour off to-night, and, by the way, we will have to make a set of rings for the brickyard engine to-morrow. Tell John to take the 12-inch pattern and nail a piece of rubber belting around it. I guess that will make it so it will clean up. Sandy says the new key we put in the gas engine at the woodshop is working out again, so send Mike down to have him drive it in. And Big Ben, the blacksmith, wants a new bolster bored to make those 2-inch pipe flanges for the boiler shop. McGee wants a half dozen nozzles faced and some 3½- and 4-inch flanges.

"And say, if Teddy comes in from the refinery tell him we will send a couple of our boilermakers up there the first thing in the morning; and as soon as Milt gets the cylinder he is working on bored out, have him cut that temper screw-box. Oh, yes, and keep Harry right on those connected valves for we have twenty five to ship out to the Territory. If Clem and Dick come back, send one of them over to the laundry, for they want a new piece put on the lineshaft; and don't forget to have those pulleys bored for the flour mill—which reminds me that the boss from the rolling mill wants those rail trucks right away, so you'd better get Dad to take the castings to the planer, so that if he comes he'll see that we've made a start.

"Have Ted put up the countershaft he took down on the screw machine for we need some sucker-rod joints very soon, and have Tom put up some cup packers for the 5⅝-inch hole —Syd wants them in the stove. Send Jim, the pipe-fitter, over to the Park Hotel; something has gone wrong with their dishwasher. Ike says he never wants to go back to the tannery, so if they send in, let Joe get a scent; and, by the way, when the team get back from the Valley Station, have them return the load of coke that we borrowed from the upper foundry and tell the joint turner that Jones Bros. want that set of all-steel bits ready to go when their team comes after the casing. Incidentally, the new man on the old lathe can help rough out working barrels if he runs shy of work.

"Well, I must catch that 1:40 car. Guess you'll get along all right. Oh, say, if my wife stops here on her way over to town, tell her—tell her—well, don't bother, she won't believe it anyhow."

At last he is off for the brewery and between you and me and the tailstock, those breakdowns are sometimes imaginary. Well, what did we do after listening to all that spiel? We have heard him before—when he was dry—so we just sat down on an empty nail-keg and tried to think out what to do first with a week's work laid out ahead and less than half a day in which to do it. Such a condition ought at least to make a person sympathize with the boss that carries a load like that around most of the time.

* * *

Foolish Question No. 1: When does a steady rest?

ASSEMBLING OPERATIONS IN THE B. & S. AUTOMATIC SCREW MACHINES—3

By S. N. BACON

The assembling operation described in the previous installment of this article was so successful that when the part shown at *A* in Fig. 8 came along it was decided to make this also in the No. 2 Brown & Sharpe automatic screw machine. Although this part was assembled in an entirely different manner, it was found to be more interesting than the preceding one. It is made up of a stud *a*, on which turns the roller *b*, held in place by the washer *c*, the latter being pressed on the stud. Referring to the part which is shown disassembled at *B* in Fig. 8, it will be seen that there are two unusual operations to be performed. The first is to ream a

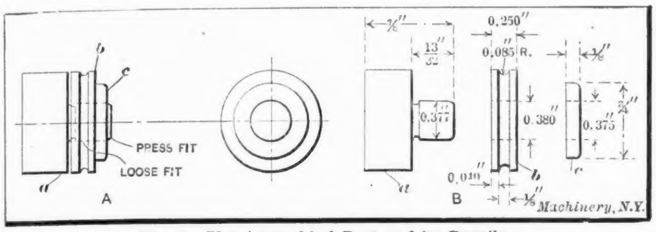


Fig. 8. The Assembled Part and its Details

large hole behind a small one, and the second is to cut off, three times, this requiring the stock to be fed out three times for the completion of each assembled part.

In operation, the stock is first fed out to the length shown at *A* in Fig. 9, where the hole is centered, drilled, and the

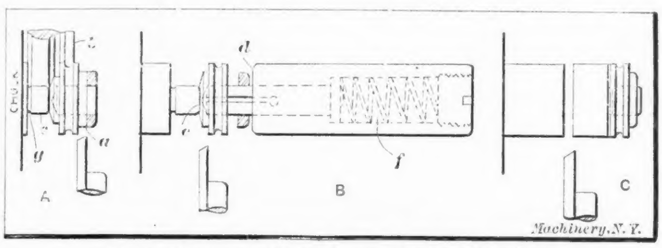


Fig. 9. Positions of Stock for the Various Operations

washer shown in section at *a* is reamed to 0.375 inch diameter. The remainder of the hole, which is in that part of the stock that will form the roller, is bored with a recessing tool to 0.380 inch. Meanwhile the circular form tool *b* has turned the hub *c* to 0.377 inch diameter, and also formed the groove in the roller. The form tool leaves sufficient stock around the bottom of the hole to hold the parts together.

Before cutting off the washer, the special tool shown at *B* in Fig. 9 comes forward and enters ⅛ inch into the hole. The pilot of this tool is slotted and spring tempered, so that it will take hold of the washer when it is cut off. When the washer is separated from the bar, the cut-off tool drops back and the stock is fed forward sufficiently to allow the roller to be cut off. The pilot tool has now entered the hole of the roller as seen at *B*, which also shows the relative position of the washer. This pilot tool is also used as the stop, the stock being fed against the face *d*.

The pilot, holding both the roller and the washer, now moves forward until the end comes in contact with the stud at *e*, when the turret still advances sufficiently to push the roller on the stud, and also to press the washer on the end, thus holding the roller in place. In the meantime the pilot has been held against the end of the stud by the coil spring *f*. The work is now fed forward to the over-all length, and cut off as shown at *C*. Provision is made for the slight burr which is left around the edge of the hole when the roller is cut off, by cutting a groove *g* in the stud, as shown at *A*. The outside diameter of the washer is turned with a box-tool, which obviates the necessity of using an extremely wide forming tool. The order of operations is as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	27	2
Revolve the turret	34	2½
Turn and center with box-tool 0.145 inch rise at 0.0054 inch feed	27	2
Form 0.350 inch rise at 0.001 inch feed	(350)	(25)
Revolve the turret	41	3
Drill 0.561 inch rise at 0.0045 inch feed	125	9
Revolve the turret	42	3
Ream 0.145 inch rise at 0.0052 inch feed	28	2
Revolve the turret	41	3
Recess front cross-slide cam 0.011 inch rise at 0.001 inch feed	14	1
Recess lead cam 0.260 inch rise at 0.0074 inch feed	35	2½
Revolve the turret	42	3
Cut off the washer 0.360 inch rise at 0.002 inch feed	180	13
Take hold of washer with pilot	—	—
Clearance	14	1
Feed stock against pilot holder	27	2
Cut off roller 0.554 inch rise at 0.002 inch feed	277	20
Clearance	28	2
Push on roller and washer 0.375 inch rise	42	3
Revolve the turret	42	3
Feed stock to stop	28	2
Cut off finished piece 0.554 inch rise at 0.002 inch feed	277	20
Clearance	14	1
Total	1385	100

With a spindle speed of 277 revolutions per minute it requires 300 seconds to complete one assembled part, which gives a gross output of 120 pieces in 10 hours. The writer is not in favor of using the combination box-tool and center tool, but in this case it was necessary as the turret was filled with tools.

Referring to the lay-out of the cams shown in Fig. 10, it will be seen that there are a number of short lobes on the lead cam. These lobes, when made accurately, will work just as well as the longer ones, because the cam is turning very slowly. The front-slide cam from 26½ to 27½ feeds the recessing tool in at right angles to the spindle, and from 27½ to 30 is a dwell, while the recessing tool is fed forward by the lead cam. The front slide drops back a little ahead of 30, so as to release the recessing tool before it is withdrawn

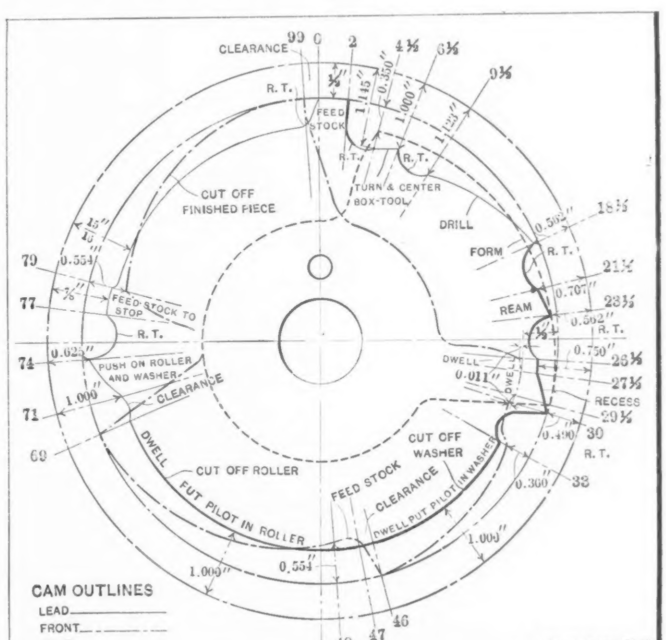


Fig. 10. Lay-out of the Cams for Making and Assembling the Various Pieces

by the turret. From 33 to 46 the front cam actuates the cut-off tool, separating the washer from the bar, and after dropping back enough at 46 to allow the roller to be fed out, it again advances and cuts off the roller. After feeding the stock again, the finished part is cut off by the lobe from 79 to 99.

The dwell on the lead cam which follows the recessing lobe keeps the spring pilot in the hole of the washer while it is being cut off. From 47 to 49 the stock is fed forward preparatory to cutting off the roller. The rise from 71 to 74 which pushes the roller and washer onto the stud was not made when the job was first set up, as it was a case of cut-

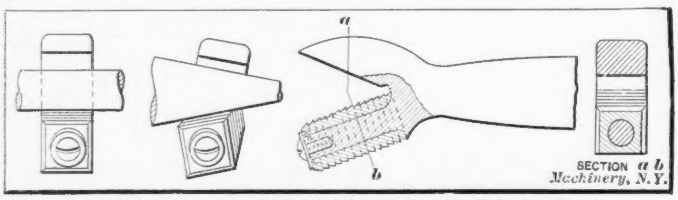
and-try, to get the proper advance. The shape of the curve shown in the illustration was finally arrived at and was successful. When the stock is fed at 77 to 79 it reaches the length shown at *C* in Fig. 9, and when it is again fed 0 to 2 it reaches the length shown at *A*. The weight of the piece causes it to drop before the cut-off tool has reached 99, so that no interference occurs when revolving from one stop to the other.

It might be well here to give the reason why one stop could not be used for these last two feedings of the stock, thus allowing space in the turret for a centering tool instead of using the combination box-tool and center. The reason this could not be done is that the difference in the length between the two feeds is so great that the cam at 77 to 79 would have to be cut very much lower than it is from 0 to 2, and in rising from the low to the higher point of the cam, the stop in the turret would strike the work before it was cut off; of course, cam space could be allowed to prevent this, but it would mean lost time.

* * *

ALLIGATOR WRENCH WITH ADJUSTABLE AND RENEWABLE JAW

An interesting improvement of the common alligator wrench is the substance of U. S. patent No. 990,050 (April 18, 1911), issued to F. O. Jaques, Jr., Cranston, R. I. The device consists, as shown in the illustration, of the usual handle end and plain jaw, and in place of an unadjustable toothed jaw, a circular projection is provided on which a square section



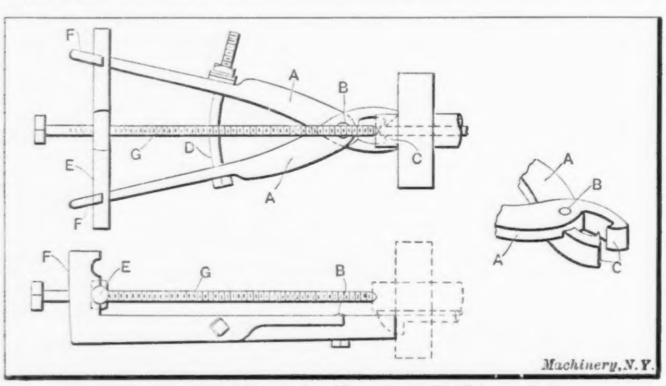
Alligator Wrench with Four-sided Renewable Gripping Jaw

of the form indicated, with teeth on all four sides, is placed. This arrangement has several advantages, for not only does it prolong the life of the wrench by having the wearing faces renewable, but it also adapts it for use on tapered work, inasmuch as the gripping jaw, being free to turn on its spindle, will conform to the taper and give a good grip, adjusting itself automatically.

* * *

DEVICE FOR REMOVING KEYS FROM SHAFTS AND PULLEYS

Jacob Butsch, Lynnville, Ind., has patented a device (U. S. patent No. 986,113, March 7, 1911), for removing keys from shafting and pulleys. The body of the device is in the form of a vise or key-gripping member with two arms *A* pivotally connected at *B* and having their shorter ends formed into key-fitting jaws *C*, as shown in the illustration. These jaws are



Patented Device for Removing Keys from Shafts and Pulleys

formed in a manner calculated not only to prevent slipping, but also to prevent a swinging or pivotal action of the device about the gripping points. The arms *A* may be clamped together with a bolt *D*, set at a sufficient distance back from the pivot point *B* to give a good clamping action. A crosshead *E* fits into recesses in the bent-up projections *F* on the ends of the arms *A*. A bolt *G* through this crosshead is set in such a manner as to press against the shaft from which the key is to be removed. The illustration shows the manner in which the device is set up for use.

KNURLS AND KNURLING OPERATIONS

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

While on a recent visit to the works of the Brown & Sharpe Mfg. Co., Providence, R. I., the writer obtained information on the subject of knurls and knurling operations which will in a measure supplement the articles previously published on this subject in the June and July, 1909, numbers of MACHINERY (engineering edition). The articles referred to dealt particularly with cross-slide knurling operations, while the present

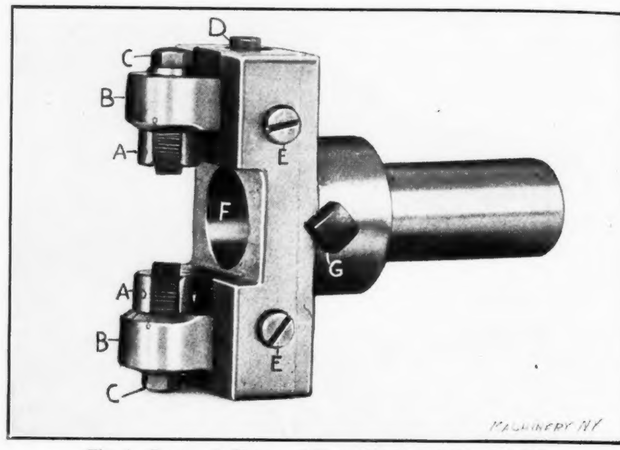


Fig. 1. Brown & Sharpe Adjustable Turret Knurl-holder

article takes up knurling from the turret, and special knurling operations.

Adjustable Turret Knurl-holder

An adjustable knurl-holder for turret knurling is shown in Fig. 1. This holder can be used for either spiral or straight knurling, as the knurl-holders *A* can be swiveled to any angle. The illustration shows the holders set with the zero mark

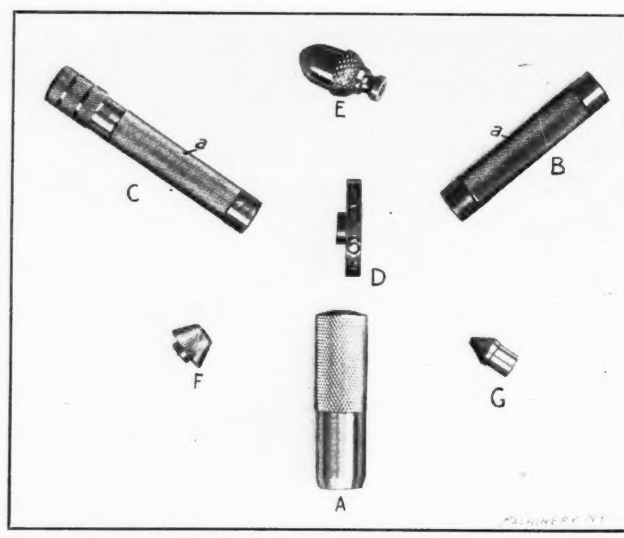


Fig. 2. Samples of Knurled Work

opposite 30 degrees, in which position the knurls would produce a diamond knurl, as shown on the piece *A* in Fig. 2. The knurl-holders *A* are held in the lugs *B* by collar nuts *C* which are screwed onto the threaded shank of the holders. Lugs *B* are graduated at 5-degree intervals, so that the knurls can be easily set to the desired angle. These lugs project into the body of the holder and fit in beveled slots cut to receive them. The lugs are adjusted in and out by means of collar-head screws *D*, only one of which is shown in the illustration. These collar-head screws are locked by means of small brass shoes, operated on by the headless screws *E*.

This knurl-holder can also be provided with bushings which fit in the hole *F* for holding centering tools or other internal cutting tools, so that other operations can be performed at the same time as the knurling operation. The cutting tools are held in position in the bushing by means of the set-screw *G*. The chief advantage of this knurl-holder is that straight

* Associate Editor of MACHINERY.

knurls can be used for spiral as well as for straight knurling. This is an important feature, as straight knurls are more easily and quickly cut than spiral knurls, and also produce better results.

Opening Knurl-holder

The range of the knurl-holder shown in Fig. 1 is somewhat limited, in that it is impossible to knurl a piece of work back from the end, when the diameter to be knurled is smaller than or of the same size as the part preceding it. For this

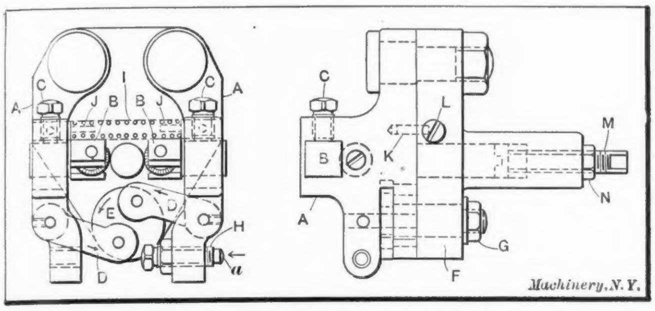


Fig. 3. Brown & Sharpe Opening Knurl-holder

class of work it is necessary to bring the knurl-holder onto the work, and then force the knurls in to the depth required, so that the work can be knurled in any desired position without passing over the whole surface. A knurl-holder which can be used for this class of work is shown in Fig. 3. This type is used especially for work similar to that shown at *B* and *C* in Fig. 2, where, as can be seen, the knurled portions *a* are practically in the center of the work.

The knurl-holder shown in Fig. 3 is made on the "swing" principle, and consists mainly of two swinging members *A*, in which the knurl-holders *B* are held by set-screws *C*. Rectangular holes are provided in the swinging members *A*, into which these knurl-holders *B* fit. As these two swinging members have to work together, it is necessary to connect them. This is accomplished, as shown in the illustration, by two connecting links *D*, attached to a stud *E* held in the main body

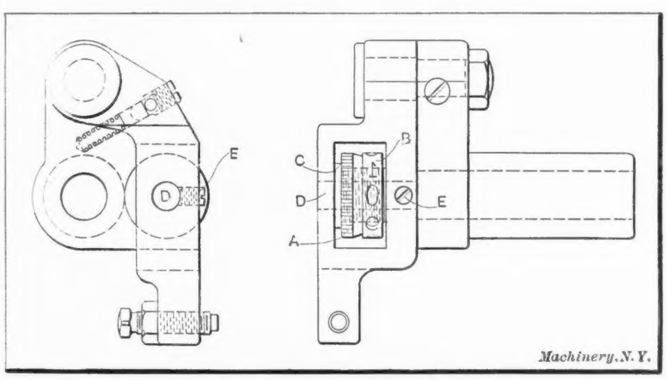


Fig. 4. Numbering Tool of the Swing Type

of the holder *F* by the nut *G* which is screwed onto the shank of the stud.

In operation, the rising block, held on the cross-slide, presses against the point *a* of the screw *H*, and forces the right swinging member *A* in the direction of the arrow. This revolves the stud *E* in the direction of the arrow, which action, in turn, draws in the left swinging arm. These members are held apart by coil spring *I* pressing against two spring plungers *J*, which, in turn, press against two pins *K* held in the swinging members. These pins *K* project into the main body of the holder, and are stopped by means of two headless screws *L*, which are tapped into the main body of the holder. The swinging members *A* are attached to the main body of the holder in the same manner as the ordinary swing tool. The knurl-holders in this case, however, cannot be set to any desired angle, but are held rigidly, so to speak, in the swinging members. The forward ends of these holders are offset so that a straight knurl is held at an angle of 30 degrees with the axis of the holder for producing diamond knurling. However, the knurl-holder proper can be used for straight knurling or other knurling from the turret, by supplying it with knurl-holders *B* of the desired shape to suit conditions.

This knurl-holder is provided with a stop *M*, similar in shape to an ordinary fillister-head screw, which is tapped into the shank of the holder. The screw is flattened on the end projecting from the holder, so that a wrench can be used for adjusting it, the nut *N*, of course, being used for locking when the stop is set in the desired position. The advantage of this stop is that when all the holes in the turret are full and it is necessary to feed the stock out again, the holder will act as a stop when the stock is fed out into it. The rise on the lead cam is, of course, used to govern the position of the knurls on the work.

Numbering Tool

In Fig. 4 is shown a swinging knurl-holder which was used for rolling figures in a wheel for a cash register. While this is not strictly a knurling operation, nevertheless knurling is performed. The method of rolling the figures on the wheels is interesting. The knurl *A* and the numbering wheel *B* are

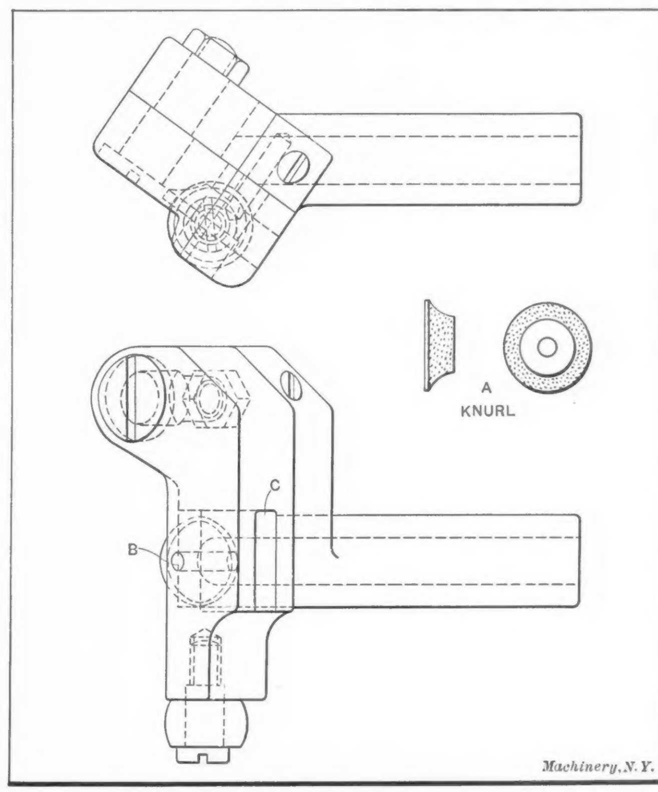


Fig. 5. Knurl-holder for Concave and Convex Knurling

made separately, and are screwed onto a sleeve *C* which, in turn, is held on a pin *D*. This pin is driven into the swinging member of the holder, and is held by a headless screw *E*.

The diameter of the knurl *A* is slightly larger than the diameter, over the figures, of the numbering wheel, so that the knurl comes in contact with the work first. The object of this is to provide a drive for the numbering wheel, so that it will not slip and "chew up" the letters, which are being rolled in the work. The knurled portion is removed after the letters have been rolled by a circular form tool operated from the cross-slide, which operation leaves the work in the con-

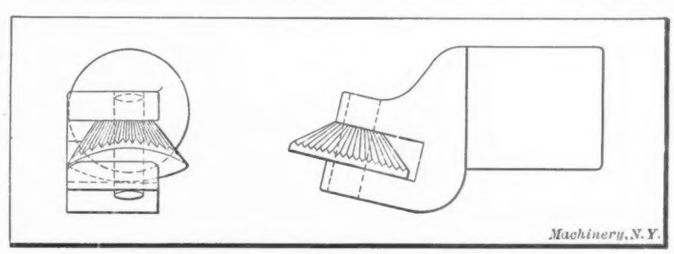


Fig. 6. Bevel Knurl-holder used in the Turret

dition shown at *D* in Fig. 2. This idea of using a knurl to drive the numbering tool is worth noting, as the same principle could be used in a number of cases for performing work of this or similar character.

Knurl-holder for Concave and Convex Knurling

At *E* in Fig 2 is shown an acorn nut, a portion of which is knurled as indicated. This operation would be difficult to

perform with a cross-slide knurl-holder, owing to the fact that the knurl could not be brought in straight—that is, having its axis parallel to the axis of the spindle—as the knurl would have a tendency to glide off. This, however, was accomplished by knurling from the turret with a knurl-holder operated by a rising block held on the cross-slide.

The knurl-holder for performing this operation, and the knurl used, are shown in Fig. 5. This knurl-holder is of the swing type, and is offset as shown. The manner of holding the swinging member is that commonly used and needs no description. The angle to which the knurl-holder is offset is such that the knurl can be held with its axis parallel to the face of the work to be knurled. The face of the work in this case, however, is convex, so that the axis of the knurl is held parallel to an imaginary line, joining the smallest and largest diameters of the knurled portion. Forcing this knurl-holder in at an angle, makes it necessary to provide a roller on the swinging member, so that the pressure can be directed in a straight line and still deflect the swinging member to the required angle without cramping. The knurl A is held on a pin B driven into the swinging member of the holder, and a rectangular hole C is cut in the swinging member into which the knurl fits.

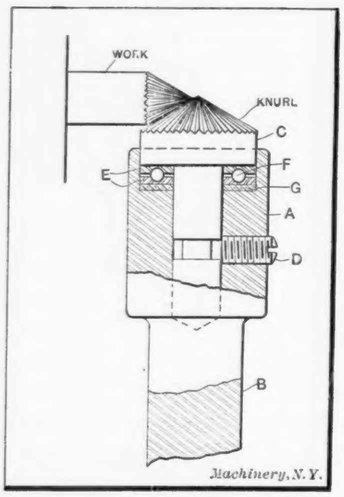


Fig. 7. Bevel Knurl-holder used on the Cross-slide

Holders for Bevel Knurling

At F in Fig. 2 is shown a piece which is beveled and knurled, and in Fig. 6 is shown the knurl and holder which were used to perform the knurling operation. The holder is of simple design and will not need further explanation. The knurl is held, as shown, at the desired angle with the work, on a pin driven into the knurl-holder. This simple knurl-holder performed the operation successfully.

At G in Fig. 2 is shown a piece somewhat similar to that at F, but it is smaller in diameter, and the included angle of the tapered portion is less. This piece was not knurled from the turret, but was operated on by a cross-slide knurl-holder of the type shown in Fig. 7. The body A of this holder is cylindrical in shape, while the shank B is of rectangular section, and is held in the cross-slide holder used for holding straight forming tools. This holder can be furnished for the Brown & Sharpe automatic screw machine when so desired. The knurl C is made with a shank, which passes into the body of the holder A and is held in the holder by a pointed set-screw D fitting in an annular groove cut in the shank of the knurl. As the thrust exerted on the knurl when in operation is considerable, it is necessary to provide this knurl-holder with roller bearings to reduce the friction. Two steel washers E act as retainers for the ball bearings F, and an additional bronze washer G is provided to separate the body of the holder from the tool-steel retainers. These retainers E are hardened, as is also the knurl C.

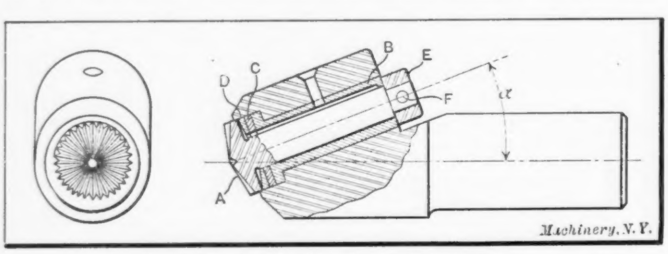


Fig. 8. Turret Knurl-holder for End Knurling

Turret Knurl-holder for End Knurling

It is sometimes necessary, when using special turret tools, especially those of the generating type, to knurl the end of the work so that the tool in the turret can be kept in step with the work. The knurl-holder and knurl for performing this class of work are shown in Fig. 8. The knurl A is held in the holder at an angle with the horizontal center line. The angle a at which the knurl is held should be from 15 to 30 degrees; about 20 degrees, however, is ordinarily used. The shank of the knurl A passes into the body of the holder and fits in a bronze sleeve B, the sleeve being driven into the holder. An oil groove is cut in this sleeve to supply oil to the shank of the knurl. A hardened steel washer C and a bronze washer D are also provided to reduce the friction. The knurl is held up against these washers C and D by a collar E, which is fastened to the shank of the knurl with a pin F.

This type of knurl-holder is also used for assembling operations. The piece to be assembled on the work in the chuck is put in place, and the knurl-holder is brought in, upsetting the end so that the part assembled cannot be taken off. A hole is usually drilled in the end of the knurl, as shown, to facilitate the cutting of the teeth.

Laying Out Cams for Turret Knurling Operations

Knurling from the turret differs from knurling from the cross-slide, in that the turret knurl-holder cannot be taken

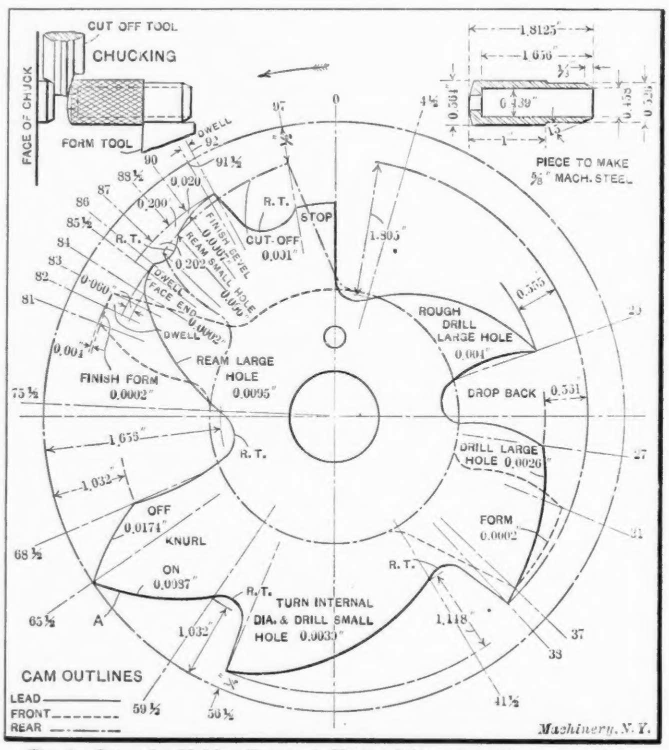


Fig. 9. Cams for Making Brown & Sharpe Micrometer Sleeve, showing method of Laying out Lobe for Turret Knurling

off the work on the quick-drop of the cam. If this were done, the knurls would "chew up" the knurling which has been made on the forward travel of the knurls. The method of laying out the rise on the lead cam for knurling from the turret is shown in Fig. 9. This is the lay-out of a set of cams for making a Brown & Sharpe micrometer sleeve, shown at A in Fig 2. The other machining operations on this sleeve, however, are not within the scope of this article, so we will turn our attention to the lobe which performs the knurling operation. This lobe is shown at A on the lead cam. It will be noted that the part of the lobe for the forward travel of the knurls covers a greater number of hundredths of the cam surface than does the part of the lobe used for backing the knurls off the work. As a rule, the part of the lobe used in backing the knurl off the work should contain about half the number of hundredths used for feeding the knurl on the work, or, in other words, the feed used for backing-off should be about twice that used for feeding on.

Designing and Cutting Bevel and End Knurls

The making of bevel knurls differs from the making of bevel gears only in that the pitch circle of the knurl is not taken into consideration, as the teeth are shallow and do not require to run in any previously formed teeth, but make

teeth by a rolling action. This rolling action displaces a certain amount of the material to form the teeth, and in so doing increases the diameter of the work, thus changing the original pitch circle. Knurling is similar to thread rolling in this respect.

In Fig. 10 is shown the ordinary method of designing a bevel knurl. Angle α, of course, is made to conform to the face angle on the work. The face angle β on the knurl can be found by the following formula: First find tan η, which is equal to $\frac{d}{A}$ (d = depth of tooth, and A = length of face cone radius of knurl.) The diameter of the knurl, D, is made to suit the requirements.

Then

$$\beta = \alpha + \eta$$

The included angles of the teeth for the knurls used in knurling different materials were given in the June, 1909,

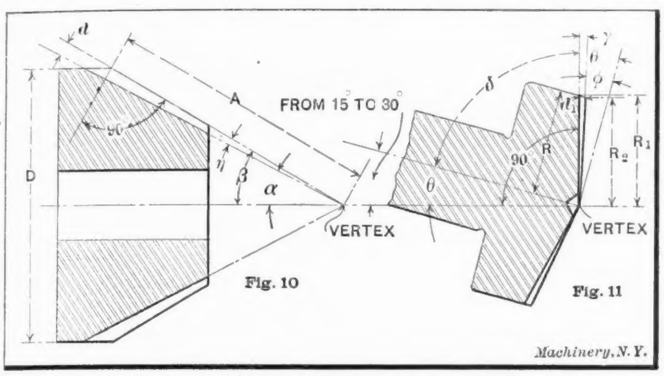


Fig. 10. Method of Finding the Cutting Angle of Bevel Knurls.
Fig. 11. Method of Finding the Face Angle of End Knurls

number of MACHINERY (engineering edition), as was also a table giving the depth of teeth for various included angles. Reference should be made to the above in connection with this article.

In Fig. 11 is shown a method of designing an end knurl. The bottom of the tooth in the knurl should be at right angles to the center line of the spindle when the knurl is held in the position shown, so that the face of the teeth on the knurl project past the perpendicular, thus forming the teeth in the work deeper at the outer circumference than at the center. In cutting the knurl, when the angle θ at which the knurl is held in the holder is known, the setting of the knurl in the milling machine is, of course, a simple problem. The face angle of the knurl has to be found, however, before the knurl can be made. This angle can be found by the aid of the following formulas, in which

θ = angle of inclination of axis of knurl,
δ = angle of bottom of tooth with axis of knurl,
γ = tooth angle,
ϕ = face angle of knurl,
R = radius of knurl, made to suit requirements,
R_1 = distance from vertex to circumference at bottom of tooth,
R_2 = distance from vertex to circumference at face of tooth,
d_1 = depth of tooth.

$$\delta = 90 \text{ degrees} - \theta$$

$$R_1 = \frac{R}{\cos \theta}$$

$$R_2 = R_1 - (d_1 \times \tan \theta)$$

$$\tan \gamma = \frac{d_1}{R_2}$$

Hence

$$\phi = \theta - \gamma$$

For example, assume that it is required to design an end knurl with the following data:

Angle θ = 20 degrees,
Depth of tooth, d_1 = 0.027 inch,
Radius of knurl, R = 0.375 inch.

Then

$$R_1 = \frac{0.375}{\cos 20 \text{ deg.}} = \frac{0.375}{0.9397} = 0.399 \text{ inch.}$$

$$R_2 = 0.399 - (0.027 \times \tan 20 \text{ deg.}) = 0.399 - 0.0098 = 0.389 \text{ in.}$$

$$\delta = 90 \text{ deg.} - 20 \text{ deg.} = 70 \text{ deg.}$$

$$\tan \gamma = \frac{0.027}{0.389} = 0.0694, \text{ the tan of 3 deg. 58 min.}$$

Hence

$$\phi = 20 \text{ deg.} - 3 \text{ deg. } 58 \text{ min.} = 16 \text{ deg. } 2 \text{ min.}$$

For some classes of work it may be necessary to have the diameter of the knurl tapering, so that the circumference is at an angle of 90 degrees or less to the face of the knurl. This, however, decreases the strength of the teeth at the circumference, and promotes chipping of the teeth.

Rise on Lead and Cross-slide Cams for Turret Knurling

Knurling from the turret can be divided into five distinct groups as follows:

1. Spiral or diamond knurling when the knurl-holder is operated on entirely by the lead cam;
2. Spiral or diamond knurling when the knurl is operated on by both the lead and cross-slide cams;
3. Bevel knurling when the knurl is operated entirely from the turret;
4. Bevel knurling when the knurl is operated on by both the lead and cross-slide cams;
5. End knurling when the knurl is operated on entirely from the turret.

The rise on the cam for knurling from the turret, subject to the conditions above stated, can be found by referring to Fig. 12. At A is shown the diagram for spiral or straight knurling when the knurl is operated on entirely from the turret. The rise on the lead cam for this operation would be $b + a$. The value a takes into consideration the bevel on the knurl, which is necessary to prevent the corners from chipping.

For spiral or straight knurling when the knurl is operated on by both the turret and cross-slide cams, the diagrams shown at B and C are used. Here the lead cam brings the knurls onto the work into the position shown, by the quick-rise of the cam. A dwell is then made on the lead cam, and the cross-slide cam forces the knurls in to the proper depth. The lead cam then advances, while a dwell is made on the cross-slide cam. The

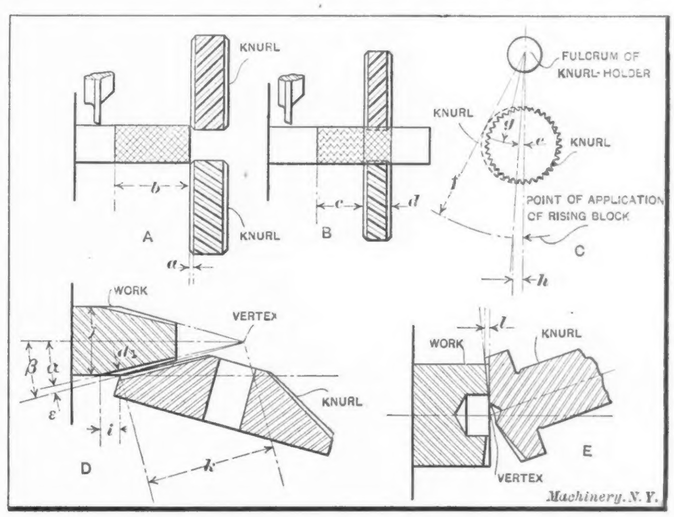


Fig. 12. Diagrams for Finding Rise on Lead and Cross-slide Cams for Turret Knurling

rise on the lead cam is equal to c, or the length of the knurled portion, minus the thickness d of the knurl. The rise h on the cross-slide cam is found by the following formula:

$$h = \frac{e \times f}{g}$$

The value e is equal to the depth of the tooth. This value is slightly greater than the rise on the cam required for knurling, as the material is displaced. However, the depth of the tooth, e, is near enough for all practical purposes.

The method of obtaining the rise on the cam for bevel knurling when the knurl is operated on entirely by the lead cam, is shown at D, where i equals the rise required on the cam. The rise i is obtained by means of the following formulas, where

k = face cone radius of work,
j = diameter of work,

i = rise required on cam,
α = angle of bottom of tooth with axis of work,
β = angle of face with axis of work,
ϵ = tooth angle,
d_1 = depth of tooth.

$$k = \frac{j}{2 \sin \beta}$$

$$\sin \epsilon = \frac{d_1}{k}$$

$$\alpha = \beta - \epsilon$$

Then

$$i = \frac{d_1}{\sin \alpha} + 0.010 \text{ to } 0.015 \text{ inch.}$$

The method used for obtaining the rise on the cross-slide cam for bevel knurling when the knurl is operated on by both the lead and cross-slide cams, is the same as that shown at *C* in Fig. 12. The holder in which the knurl is held is offset, so that the face of the knurl is held parallel with the face of the work when being fed in. The depth of the tooth, therefore, is used for obtaining the rise on the cross-slide cam, by the aid of the diagram shown at *C*. No rise is required on the lead cam, as the knurl is brought to the correct position on the work by the quick-rise of the cam, and then allowed to dwell until the knurling is completed.

FEEDS FOR TURRET KNURLING

Pitch of Knurl	Brass Rod, Feed per Revolution	Gun Screw Iron, Feed per Revolution	Machine Steel, Feed per Revolution	Tool Steel, Feed per Revolution
16	0.0100	0.0080	0.0060	0.0040
18	0.0105	0.0084	0.0063	0.0042
20	0.0110	0.0088	0.0065	0.0044
22	0.0115	0.0092	0.0068	0.0046
24	0.0118	0.0096	0.0070	0.0048
26	0.0123	0.0100	0.0072	0.0050
28	0.0128	0.0103	0.0074	0.0051
30	0.0135	0.0106	0.0076	0.0052
32	0.0140	0.0110	0.0078	0.0053
34	0.0145	0.0115	0.0080	0.0054
36	0.0150	0.0120	0.0082	0.0056
38	0.0153	0.0125	0.0084	0.0057
40	0.0158	0.0128	0.0086	0.0058
42	0.0164	0.0132	0.0088	0.0059
44	0.0168	0.0136	0.0090	0.0061
46	0.0173	0.0140	0.0092	0.0062
48	0.0178	0.0143	0.0094	0.0063
50	0.0182	0.0145	0.0098	0.0064
52	0.0185	0.0148	0.0103	0.0065
54	0.0189	0.0150	0.0108	0.0066
56	0.0193	0.0153	0.0111	0.0067
58	0.0195	0.0156	0.0115	0.0068
60	0.0198	0.0158	0.0118	0.0069
62	0.0200	0.0160	0.0120	0.0070

The method of obtaining the rise on the lead cam for end knurling is shown at *E*, where it can be seen that the rise l equals the depth of the tooth.

Speeds and Feeds for Knurling

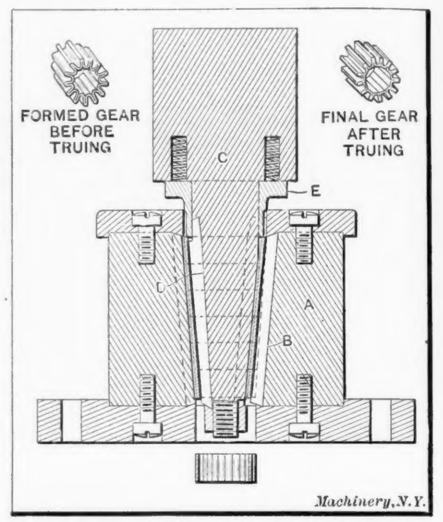
Knurls, as a rule, can be operated at about the same speed as circular forming tools, if the proper feed is given and the knurl is provided with a copious supply of good lard oil. However, it may be advisable in some cases, especially when knurling tool steel or drill rod, to decrease the speed somewhat.

Definite information cannot be given for feeds for turret knurling, as it is impossible to take into consideration all the various conditions under which a knurl will be operated. When two knurls are employed for diamond or spiral knurling, the knurls can be operated at a higher rate of feed for producing a spiral than they can for producing a diamond knurl. The reason for this is that in the first case the two knurls would be working in the same groove, whereas in the latter case the two knurls are working independently of each other, so that each has to do its own share of the work. Another condition encountered is end knurling where the knurl only has to be fed in to the depth of the tooth. Here the feed varies, of course, from that used for spiral or diamond knurling; so it is obvious that no definite rule can be laid down which will cover all conditions. The diameter of the work is also a determining factor, making the problem still more difficult. Feeds for turret knurling are given in the accompanying table for knurling different materials. The feeds here given are applicable particularly to spiral and diamond knurling, but can also be used, with judgment, for bevel or end knurling. The diameter of the work is not taken into consideration, and allowance should be made for this when using the feeds given. The feeds to be used for backing the knurls off the work should be as follows: For brass, screw stock and machine steel, twice the feeds given in the table; and for tool steel, three times the feeds given in the table.

* * *

MAKING GEARING OF SHEET METAL

U. S. patent No. 985,905 (March 7, 1911), issued to Allen Johnston, Ottumwa, Iowa, describes an interesting method of forming gears from sheet metal. Referring to the illustration, *A* is a die body which contains in a central tapered hole a series of hardened steel ribs *B*, extending lengthwise of this hole and held top and bottom by the beveled members shown. The punch body *C* is similarly arranged with a series of lengthwise ribs *D*, also held in place by beveled connections, as indicated. The ribs of the punch alternate with the ribs of the die, both sets being equidistantly spaced around the circumference.



First Punch and Die of a Patented Set for Forming Sheet-metal Gears. The Finished Product is shown in the Upper Right-hand Corner

A sheet-metal ring, preferably a short length of metal tube such as die-drawn steel, of the requisite diameter, is placed under the punch, and when the latter is at the top of the stroke the blank will be caught by the lower edge of ring *E*, which encircles punch *C*, and forced down between the converging ribs of the punch and die. Succeeding blanks force the blank to continue its passage through the die hole, corrugating the blank to the desired depth, when it is forced out at the bottom. After this, the teeth, which are properly spaced by this process, are closed to form the teeth of the gear, seaming up the space left by the ribs of the punch member. To obtain this result, the sides of the outer bends of the corrugations are subjected to lateral pressure, whereby they are brought into approximate contact with each other to form rough gear teeth. After the bends of the crimps are closed, the gear is subjected to a truing action which brings the teeth into regularity of form, and at the same time forges the walls of the crimps into substantially solid teeth, particularly at the crowns. This is done either by cold or hot forging in a specially arranged punching die which consists of a plain blank of the inside diameter of the rough gear blank, which holds the gear centrally. Properly shaped teeth attached to the die by spring members are forced radially inward by the tapered walls of the die, which the outside of these spring-connected teeth strikes, when the punch descends. These gears, before and after the truing operation, are shown in the upper part of the illustration.

* * *

According to the *Brass World*, coffin hardware is first nickel-plated and afterwards given a very light deposit of silver. This is done because if the light silver deposit were put directly on the soft metal (lead and antimony), it would be absorbed in a comparatively short time, as soft metals in general have the property of absorbing light deposits of silver and copper.

TOOLS AND METHODS USED BY THE OESTERLEIN MACHINE CO.

A number of interesting tools and methods are used in the shops of the Oesterlein Machine Co., Cincinnati, Ohio. The accompanying illustrations show a few of these, and a brief description of their construction, action and advantages will be given in the following article.

Method of Boring Cone Pulleys

In Fig. 1 is shown a method for boring out and turning the inside of cone pulleys for milling machines. The pulleys are first rough-turned on the outside and are then put into a holder or head, this latter being screwed onto the lathe spindle nose. This holder is shown in detail in Fig. 2. It is finished all over on the inside, and is split part way as indicated, so that when the cone pulley has been put into place, it can be securely clamped by means of two bolts, one through each of the lugs on the sides of the head. Two clamps, one on each side, as best shown in Fig. 1, hold the end face of the pulley against a finished face in the holder,

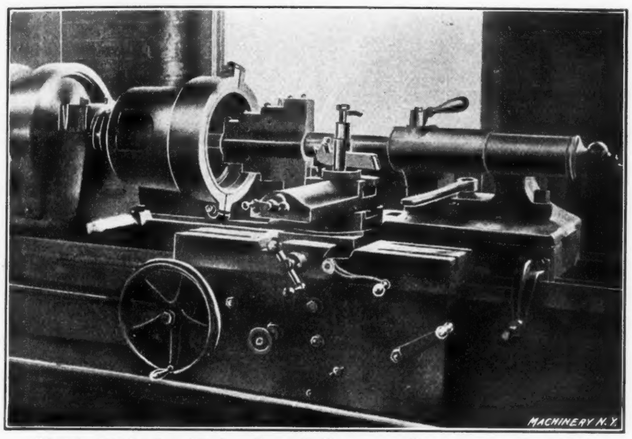


Fig. 1. Method of Boring Cone Pulleys practiced by the Oesterlein Machine Co., Cincinnati, Ohio

so that all the pulleys will be alike after the inside turning is completed.

The work is done in a twenty-four-inch lathe, and the facing and boring are done by tools held in a cutter head, all the tools being fed into the work simultaneously. In all, thirteen tools are fed in, twelve of which are held in the cutter head illustrated in position in Fig. 1, and shown in detail in Fig. 3; one of the tools, for facing the outside end of the pulley, is held in the regular toolpost. The cutter head has provision for holding eight boring tools, for boring out the four steps in the cone pulley, and for four facing tools, one of which is indicated by dotted lines, in Fig. 3, for facing the steps on the inside. A stop *A* is provided for preventing the cutter head from being fed into the pulley more than the required distance.

The arbor on which the cutter head is supported is held in the tailstock of the lathe. The tailstock spindle is removed,

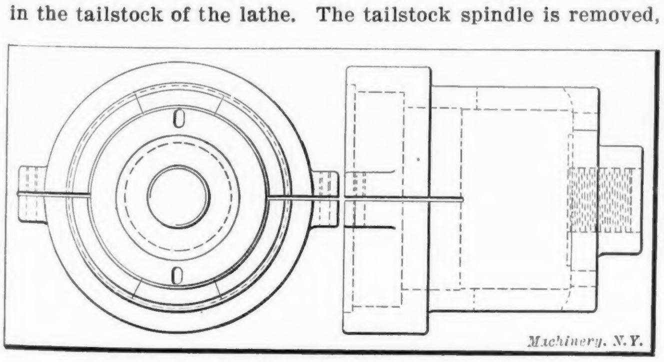


Fig. 2. Device for Holding Cone Pulleys while being bored

and in its place a long, heavy bar, reaching across the carriage, is inserted, this bar acting as the arbor on which the cutter head is mounted. The front end of this arbor is supported, when the tools are in action, by a bronze bushing inserted in the spindle. This prevents any springing action of the arbor or chattering of the tools, and tends to produce true and smooth surfaces in the pulley being bored.

The work can be turned out with considerable rapidity by this device. The total time required for the inside turning and facing of a four-step cone pulley having 4-inch steps, the largest step being 12 and the smallest 6 inches in diameter, is about 30 minutes. This is the average time for a lot of 60 cone pulleys, and includes the time required for setting-up, tool grinding, adjustment, etc.

The cutter head is fed into the work by operating the carriage feed, the tailstock being attached to the carriage by means of two bolts between the shears.

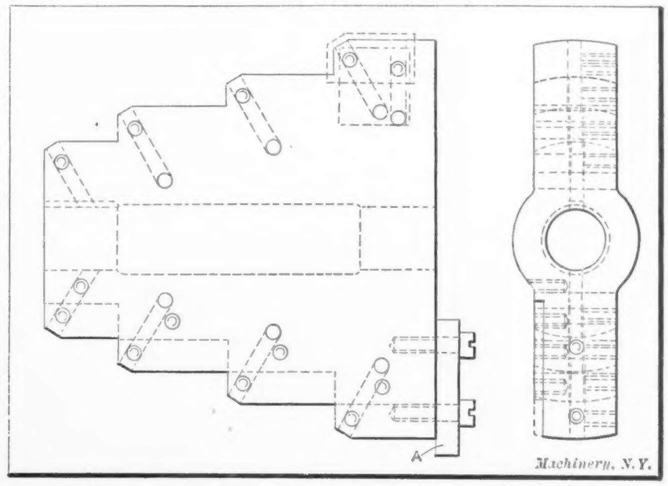


Fig. 3. Boring Head used for Boring and Facing Inside of Cone-pulley Steps

Fixture for Milling Spanner Wrenches

In Fig. 4 is illustrated a convenient method for milling spanner wrenches. About a dozen wrenches are clamped in a fixture as indicated, a stop being provided at the bottom, in the front, and two clamps on the side, one at the top and one at the bottom. A specially shaped cutter is used for milling the end and rounded portion of the spanner wrench to the required form. The advantages gained are the rapidity with which the work can be done and the accuracy and interchangeability obtained in the products.

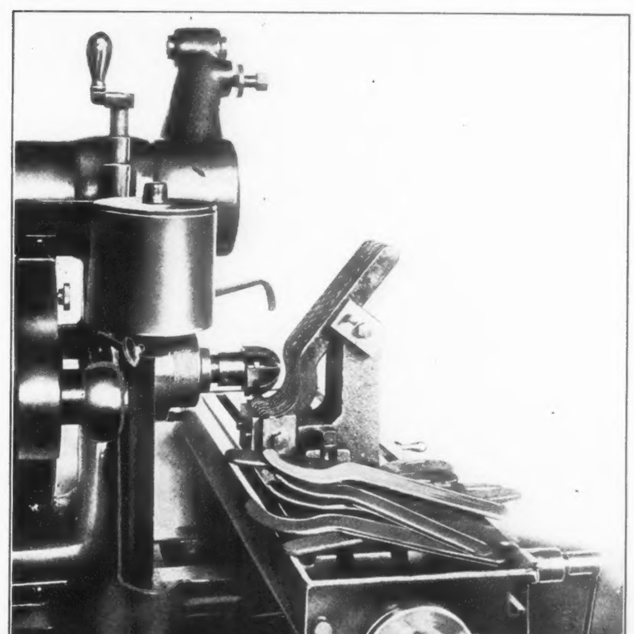


Fig. 4. Method of Milling Spanner Wrenches

Handwheel Turning Device

In Fig. 5 is shown an interesting and convenient device for turning the outside rounded surface of handwheels. The device is placed on the cross-slide of a lathe carriage, and can be used for any diameter of wheel within the capacity of the lathe. It can also be used for handwheels with rims of

different radii, by moving the turning tool in or out in its holder. The device consists of a base-plate, fitted to the cross-slide. The upper part of this base-plate is provided with a circular projection, on the cylindrical face *D* of which teeth are cut as shown. On the base-plate, and pivoted at its center, is mounted a tool-holder *C*. This tool-holder can be rotated about the center of the base-plate by means of a small pinion placed on the lower end of the upright shaft *A* shown in the illustration, which is provided with a handwheel *B* at its upper end. In this way, when the handwheel *B* is operated, the tool-holder *C* will move in a half-circle about the rim of the handwheel, and thus the rim will be finished to the required shape.

Jig for Drilling Cutter Grinder Dog

In Fig. 6 are shown three devices, each of which is of considerable interest. The one shown at *A* is a jig for drilling dogs used on a cutter grinder. The features of this jig are the simplicity of the locating and clamping means and its

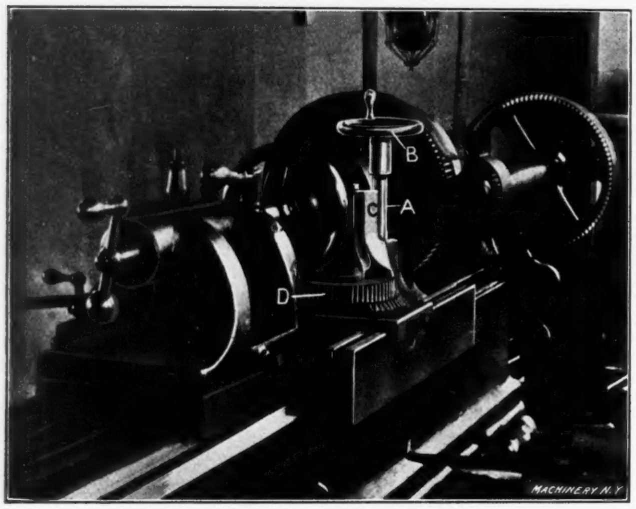


Fig. 5. Turning the Rim of a Handwheel

adaptability to dogs of varying shapes and sizes, as indicated by the collection in the front of the jig. The hole to be drilled is the set-screw hole in the dog, and the latter is located for the drilling by means of a cone center entering the large center hole in the dog. This cone center is made in one piece with clamping-stud *B*. The dog is further located by a spring plunger *C*, which enters into the slot *D* in the dogs. Clamping-stud *B* slides freely in its hole in the jig body, but a key prevents it from turning. The clamping is effected by screw *E* passing through the swinging arm *F*, which swings out of the way when a piece of work is removed or inserted, as clamping-stud *B* must then move outward. When the arm is again in position one turn of the binding screw will clamp the work. The device is very quickly manipulated, and is

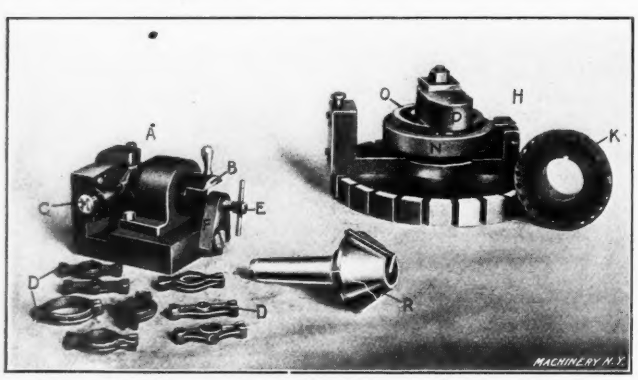


Fig. 6. Two Examples of Drill Jigs and a Combination Centering Tool and Cone Center

very convenient on account of the wide range of sizes it can take care of.

Jig for Drilling Index Worm-wheels

At *H* in Fig. 6 is shown a jig for drilling the holes for direct indexing in an index-head worm-wheel. The advantages of the jig are the accuracy obtained, the elimination of broken drills, and the convenience of operation. Instead of having a jig with twenty-four guide bushings, one for each hole to be drilled, this jig has but one guide bushing, and it remains always in a fixed position beneath the drill spindle. In the illustration, *K* is one of the index worm-wheels which has been drilled, and another is shown in the jig at *O*. The base *L* of the fixture is an index-plate, which is secured to the drill-press table when the jig is in use. Members *M* and *N* are movable, and hold the work to be drilled, these parts

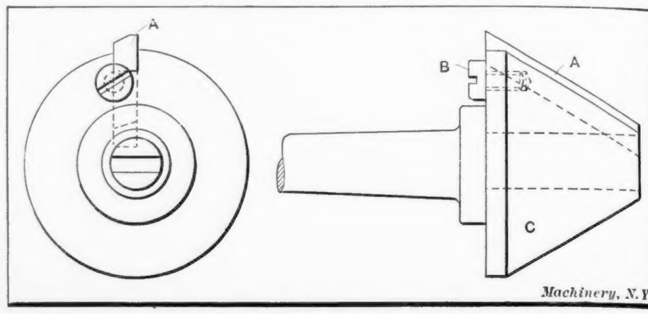


Fig. 7. View showing Principle of Combined Centering Tool and Cone Center

being pivoted at the center of the index-plate. Guide-bushing holder *P* is secured to the index-plate, and, hence, is stationary. The action of the device is simply that the work is indexed for each hole to be drilled, the jig itself remaining in a fixed position. This insures that the drill is always in line with the guide bushing, after it has once been so adjusted, and the difficulties due to non-alignment of drill and drill bushing are avoided. A 5/16-inch drill, as used in this case, would not be able to pull a heavy fixture into place, if drill and bushing were not in line, and the drill would most likely break. The greater accuracy obtained, and the simplicity and convenience of operation are the main advantages obtained by the use of this fixture.

Combination Centering Tool and Cone Center

At *R* in Fig. 6 is shown a combination centering tool and cone center which has been found very convenient. A detailed

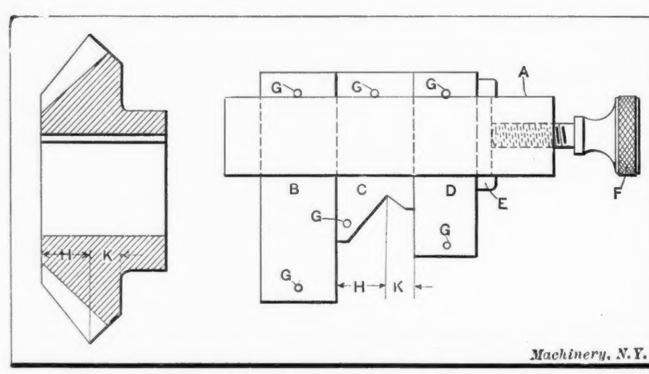


Fig. 8. A Gage for Turning Bevel Gears

view of the construction of this tool is shown in the line-engraving Fig. 7. The tool is used first for centering the front bearing box for a milling machine, before turning, and is afterward used as a revolving cone center, the tool having been removed. The end of the hole in the bearing-box casting is rough, so that it is impossible to use it as a support while turning the outside, unless it is first centered. The purpose of the tool shown is to eliminate a separate centering operation, and to provide a rapid means for centering the box, so as to obtain a true bearing surface for the cone center. This is accomplished as follows: The tool is held in the tailstock of the lathe and the bearing box is chucked as usual. The operator then slips tool *A*, Fig. 7, into its slot, in which it is held endwise by the head of screw *B*. He then brings up the tailstock spindle toward the work, and centers it. Then the tool *A* is removed, and the member *C*, when brought into position, acts as a cone center. The operator is now ready to proceed with the turning. When centering, the tool *A* itself acts as a key, locking the cone center and the arbor together, so that the tool will not revolve about the arbor while centering, although the cone center itself is of the revolving type.

Gage for Turning Bevel Gear Blanks

In Fig. 8 is shown a convenient gage used when turning bevel gear blanks; by means of this gage the correct angles and the dimensions of the face and the thickness of the gear are quickly and accurately obtained. The gage consists of a holder *A* made of rectangular cross-section and having a rectangular slot through it, into which the gage pieces *B*, *C*, and *D* are inserted. A binding shoe *E* is provided, against which screw *F* is tightened when it is required to hold the gage pieces in position. The latter pieces have a free sliding fit in the slot in holder *A*, so that they can move easily when not clamped by screw *F*. Pins *G* are provided to act as stops, so as to prevent the gage pieces from sliding out of the holder. On the side of the holder is stamped the number of the machine and the size of the gear for which the gage is used, so as to prevent mistakes in the use of the tool.

When turning the blanks, the face angle is first machined, and the gage is used for obtaining this angle and distance *H* (see section of gear to the left in Fig. 8). When first gaging the angle, parts *B* and *D* can be moved back, out of the way. When the width of the gear is gaged, *B* and *D* are moved back into the position shown in the engraving. The dimensions *H* and *K* of the gear correspond to distances *H* and *K* in the gage. One of the principal advantages of this tool is that it permits the gear to be gaged without taking it off the mandrel. In addition, the mistakes frequently made in measuring angles by regular bevel protractors are guarded against. With this gage there is no possible chance, or, at least, no excuse, for a mistake in angles or dimensions. E. O.

* * *

COOPERATIVE ENGINEERING EDUCATION

The system of engineering education inaugurated by Prof. Schneider of the University of Cincinnati, under which students work one week in the class room and one week in the shop, seems to meet with general favor. In one instance, a large steel and concrete construction company was requested to take two or more students to work in its shop in connection with its outside contracting work. The chief engineer of the company advised against employing the students. He was not in favor of employing college graduates when out of college for the first few years, anyway, because of the difficulty of making them apply themselves conscientiously to the simple duties at first entrusted to them, the average young engineer usually appearing to believe that his education fits him to begin somewhere else than at the bottom of the ladder. The chief engineer in question believed that the case would be somewhat similar with these students from the university. This belief seemed well founded, especially as the work of the company, because of its very nature, is more or less spasmodic, and at certain periods there is comparatively little to do. At such times some very simple work, laborer's work, in fact, might have to be given to the boys, and the chief engineer expected that this would cause dissatisfaction and trouble. However, the boys were taken on, and it is very gratifying to state that they have worked right along, doing, with apparently equal enthusiasm and efficiency, any kind of work given to them. The Schneider system of engineering education seems to eliminate the objectionable features which manufacturers and mature engineers have always been prone to point out in the young college graduate. The Cincinnati method of "catching them young" seems to have a great future ahead.

* * *

The Toledo Machine & Tool Co., Toledo, Ohio, manufacturer of punch presses, drop hammers and other sheet-metal working tools, makes a practice of giving the speed at which its machines should be operated. On the punch presses the speed of the flywheel is stamped on the rim, as is also an arrow indicating the direction in which the flywheel should be rotated. This appears to be information that is worth while, and is useful not only when setting up the machine for the first time, but also when replacing the belt, should it come off, as it is a common occurrence for a punch-press operator to put the belt on so that the press is driven in the wrong direction.

HOLDERS FOR SCREW MACHINE CHUCKS

The accompanying illustrations show two types of holders used when grinding screw machine chucks in the shops of the L. S. Starrett Co., Athol, Mass. The holders are of simple design, and are well adapted to meet the requirements. In Fig. 1 is shown the type of holder used for grinding Nos. 1

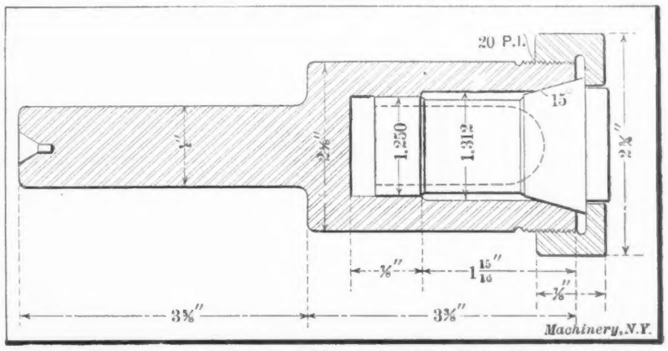


Fig. 1. Holder for Grinding No. 1 Brown & Sharpe Screw Machine Collets

and 2 Brown & Sharpe screw machine chucks. The dimensions given in the illustration are for the holder for the No. 1 machine. This consists of a main body made of machine steel, carbonized and hardened, and a cap made of machine steel, knurled on the outside, and casehardened. The part to

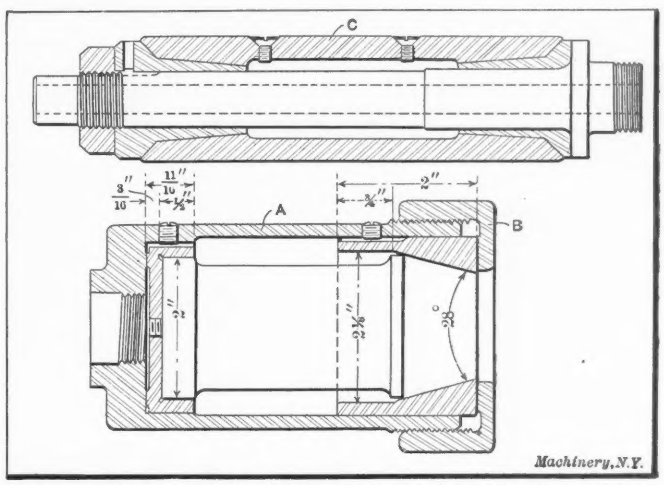


Fig. 2. Holder and Quill for Grinding Hartford and Pratt & Whitney Collets

be threaded is protected from the carbonizing influence during this process, and the thread is cut after hardening.

In Fig. 2 is shown the type of holder used for grinding screw machine chucks for the Pratt & Whitney and Hartford screw machines. The same chuck body *A* and cap *B* are used for a number of sizes of chucks, but adapter bushings are made

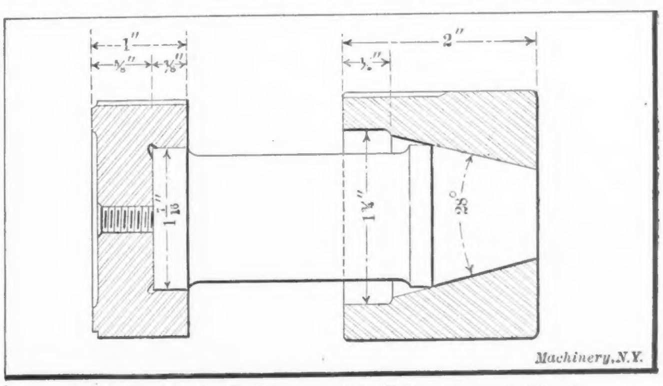


Fig. 3. Adapter Bushings used in Holder shown in Fig. 2

as indicated in Fig. 3, two bushings, of course, being required for each size of chuck. The quill shown at *C*, Fig. 2, is screwed into the end of the chuck body *A*, the end of the spindle being a tight fit in the chuck body both on the threaded part and in the plain, straight hole. The quill and chuck holder are not taken apart after they are once assembled. The chuck-seats and angles in the bushings that fit into holder *A* are ground in place after assembling the quill and chuck body, the bushings, which are made of machine steel, having previously been carbonized and hardened.

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MACHINERY

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

SCIENTIFIC MANAGEMENT AND ECONOMIC PROBLEMS

In December, 1906—nearly five years ago—Mr. Frederick W. Taylor read his famous presidential address "On the Art of Cutting Metals," before the American Society of Mechanical Engineers. Although the discovery of high-speed steel by Taylor and White in 1898 had effected a revolution in the design of machine tools in general, comparatively few at the time recognized the fact that a new era in manufacturing had dawned—not simply because of the discovery of a new cutting steel, but because of the development of a system of managing men which had accomplished results never before attained, and which is destined to have far-reaching effects.

The great interest in Mr. Taylor's address before the National Machine Tool Builders' Association in Atlantic City last May shows that machine tool builders are studying production methods and management as they have never studied them before. Comparatively few of the builders of metal-working machines know what the possibilities of their product are or how to determine them. They heard with astonishment of cases where production has been multiplied eight-fold by studying the operator at work and reducing to a minimum the number of his movements necessary to produce a part. The result of scientific management is reduction of labor costs and increase of wages.

In his address, Mr. Taylor spoke of the limitation of output as being one of the greatest evils of our times. Workmen are generally deluded with the belief that their prosperity as a class depends upon doing as little and getting as much for it as they can. This is a fundamental error, as everyone should know who has made even an elementary study of economics. Workmen are the chief consumers, and if they produce little there is a scarcity of manufactured goods to consume—a condition that is indicated by high prices. But the inefficiency of workmen directly engaged in manufacturing is not the only cause of high-priced output. Inefficient selling organizations, high transportation rates, high tariff, private ownership of land and valuable franchises, are a few of the other conditions which limit output and raise prices. Mr. Taylor's scientific management is a wonderfully efficient means of producing at low cost; but until the cost of marketing is reduced, the consumer will continue to pay too much for his commodities. Along with scientific management we should have scientific business methods and scientific government, in order to cheaply distribute commodities that are cheaply produced. Many of the departments of the national government furnish striking examples of waste and inefficiency.

* * *

SELLING MACHINE TOOLS

The salesman who can market machine tools successfully must be of a different type and training from those who sell commodities. He must possess, besides the selling faculty, a thorough mechanical knowledge of his machine, and the ability to take off his coat and demonstrate it at a moment's notice. The modern purchaser of machinery is keenly alive to the importance of getting the machine best adapted to his work, and of paying no more for it than he must; and a salesman who doesn't thoroughly understand his business will find that the possible buyer knows more about the subject than he does.

The peculiar combination referred to is seldom found in one person, and the most successful machine tool salesmen have been graduated from the shop, worked into a thorough knowledge of their specialty, and educated in the selling end—a process which requires time and doesn't always result as the employer hopes.

Machine tool manufacturers sometimes complain that dealers' salesmen don't give enough time to pushing their particular machines. How can they, when they have a hundred different machines to sell? A salesman's business is primarily expressed in figures, and when he is selling a line of standard tools of various kinds, totals can most readily be increased by selling what a customer wants, or thinks he wants, rather than by educating him to see that he doesn't know what he wants, but should have another machine than the one he had in mind. This condition has resulted of late in a constantly increasing number of specialists, who cover their territory systematically; and if they can't sell a man a machine no one can. Even on standard tools like lathes, planers, etc., the most successful manufacturers employ their own specialists to supplement the work of their agents.

* * *

THE INDIRECT CUSTOMER

Many people connected with the manufacturing end of a business consider that advertising and publicity matter which reaches any one except actual prospective buyers is wasted; and although it does seem wasteful to distribute expensive catalogues to every one who asks, many concerns make it a practice to do so, and feel that it has been profitable. It has been said, with a great deal of truth, that "the opinion of the man who may never buy, often guides the man who buys"; and that is the real reason why it pays to distribute advertising literature to inquirers who may not themselves be buyers but whose opinions and advice may count when those in authority are ready to decide on the buying of new equipment. The opinion of a machine operator working under obscure conditions in the shop, and perhaps never coming into direct contact with the purchasing department of his own firm, has often an influence on the purchase of a machine such as he is operating. His opinion is transmitted to the foreman, through the latter to the superintendent, and then to the manager; and somehow the unanimous opinion of the operators will very likely be the prevailing opinion in the organization when a machine is bought. Therefore it is worth while to convince the operator of the advantages of the machine, and to point out to him through the channels of advertising literature, the best methods of operation and the means of avoiding difficulties in the working of that particular machine.

The same logic also applies to advertising in engineering journals. There is a kind of public opinion in industrial plants as well as elsewhere which is very powerful, and every person who tries to reach customers through advertising, whether by catalogues or through the engineering press, should remember the maxim that "the opinion of the man who may never buy often guides the man who buys."

SUGGESTIONS FROM READERS ALWAYS WELCOME

Many readers of MACHINERY occasionally feel an impulse to write to the editor suggesting some topic for publication, or criticising an article that has been published, but hesitate for fear their suggestions are not desired.

We are always glad to receive criticisms and hints from readers, no matter what their positions are or what their experiences have been. Every reader has a right to expect that MACHINERY will, one time or another, treat practically every phase of machine shop practice; and if any subject has been neglected, the reason is that we have not recognized the need, or have not found a man with the practical experience required to write on it authoritatively.

Although special knowledge is necessary to write an informative article on almost any subject, an observing man will obtain ideas of general interest from a comparatively short mechanical experience. There is hardly a reader of this article who cannot add some bit of personal knowledge of shop practice which is unknown to the majority of mechanics. Machinists working in repair shops connected with mills and factories have peculiar problems to handle, and peculiar methods are developed for doing work unknown to machine shops engaged in manufacturing or general jobbing work. We want to know about such operations even though it may not be feasible to describe them at the time. Write us about them.

Die-casting, permanent mold work, cold drawing, deep-hole drilling, rifling, muffle brazing, aluminum soldering, mechanical assembling, machine tool repairing, alignment of shafting, erecting large engines, boring cylinders, repairing broken gears, handling men and teaching apprentices, shop management, drafting-room methods, making or breaking press fits in different places, treating steel for permanent magnets, refined methods of producing precision work, practical mathematical problems, laying out and erecting cams, eccentrics and cranks, are a few of many topics of general interest.

What articles would you like to see published? What articles published during the past year have been of the most interest to you, and what ones have interested you least?

* * *

ARE TRADE SECRETS WORTH KEEPING?

The difficulty of keeping a manufacturing process secret is well known to all who have had occasion to employ methods of the kind known as "trade secrets." As long as the method requires that hired help be employed, and as long as men wander from employer to employer in search of better compensation or working conditions, so long will it be extremely difficult to employ trade secrets in manufacturing which for any length of time will remain unknown to competitors.

There are numerous instances of competing firms employing the same or similar means for accomplishing the same results, which each firm zealously guards from its competitors; but as the men who move from place to place learn of these methods there are very few trade secrets which an enterprising manufacturer cannot come into possession of through employes who have at one time or another worked for a competitor.

This condition is recognized by discerning manufacturers in many lines. One firm which for several years has kept secret the design of certain machines used in its manufacturing processes, has apparently concluded that sole dependence on this method is unsatisfactory and unsafe, and patents are now being taken out to protect the machines and methods from infringement. This course undoubtedly is much wiser than trying to keep the methods secret. As a rule, it may be said that wherever a large number of men are employed, the mere fact that certain methods are kept secret furnishes an incentive to find out about them; and the employes are certain to give them more attention than if nothing were done to conceal the design of the machine or the method. Each manufacturer of course must follow his own judgment as to the better policy; but it is worth noting that the firms who have no trade secrets, and who show freely all their methods to the interested visitor, are, as a rule, fully as prosperous and successful as those whose shops and methods are, in a way, under lock and key.

CALCULATING CENTRIFUGAL FORCE*

The calculation of the centrifugal force in a flywheel or pulley rim requires considerable time on account of the several factors entering into the generally used formula. The sum of the centrifugal (radial) forces of the whole rim of a flywheel is:

$$F = \frac{W v^2}{g R} = \frac{4 W \pi^2 R n^2}{3600\, g} = 0.000341\ W R n^2$$

in which

F = centrifugal force in pounds;
W = weight of rim, in pounds;
v = velocity of rim, in feet per second;
g = 32.16 = acceleration due to gravity;
R = mean radius, in feet;
n = revolutions per minute.

The formula is not, however, in most cases as convenient in this form as it would be if the radius were given in inches. Let r be the mean radius in inches. Then

$$F = 0.000028416\ W r n^2$$

Now let $C = 0.000028416\ n^2$. This, then, is the centrifugal force of one pound, one inch from the axis. The formula can now be written in the form:

$$F = W r C$$

If C is calculated for various values of the revolutions per minute n, and the calculated values of C tabulated as in the accompanying Data Sheet Supplement, then the arithmetical work of the calculation of centrifugal force may be reduced to a minimum. It is simply required to find the value of C in the table and to multiply it by the product of W and r, the five multiplications in the original formula given thus having been reduced to three. The saving in time is, of course, not as decided as in many other cases where tables may reduce the arithmetical work to but a fraction of that generally required, but the saving is nevertheless well worth while.

* * *

CALCULATION OF BENDING AND TURNING MOMENTS FOR ROUND SHAFTS†

The bending moment for a beam or shaft of any cross-section may be expressed by the well-known general formula:

$$M_b = \frac{S I}{c} = S Z$$

in which

M_b = bending moment in inch-pounds,
S = working stress in pounds per square inch,
I = moment of inertia of section about an axis passing through the center of gravity,
Z = section modulus, or moment of resistance,
c = distance from center of gravity to most remote fiber.

For circular cross-sections

$$I = \frac{\pi d^4}{64}, \text{ and } Z = \frac{I}{c} = \frac{\pi d^3}{32}$$

In actual calculations, most of the time is consumed in carrying out the arithmetical work involved in determining the moment of inertia I, and the section modulus Z. In order to eliminate this work in calculations for round shafts of ordinary proportions, the tables in the accompanying Data Sheet Supplement have been prepared. These tables give the values of I and $\frac{I}{c}$ (= Z) for shafts from 1 to 10 inches. The table may also be used for other diameters by multiplying the values given by the cube or fourth power respectively, of the ratio of the diameter for which the values are to be found to the diameter given in the table. For example, if the moment of inertia of a shaft 10 inches in diameter is required, find in the table the moment of inertia for a shaft of 1-inch diameter, and multiply this value by 10,000, which is the fourth power of the ratio of the two diameters. The moment of inertia of the 1-inch shaft is 0.04909. Hence, the moment of inertia of a 10-inch shaft is 490.9.

* With Data Sheet Supplement.
† With Data Sheet Supplement. For section moduli and moments of inertia, advancing by sixteenths, eighths, and fourths, see Data Sheet No. 87.

The twisting moment for a beam or shaft of any cross-section may be expressed by the formula:

$$M_t = \frac{S\,J}{c}$$

in which

M_t = twisting moment in inch-pounds,

J = polar moment of inertia of section,

and S and c have the meaning previously given.

For circular cross-section

$$J = \frac{\pi d^4}{32}, \text{ and } \frac{J}{c} = \frac{\pi d^3}{16}$$

The values of J and $\frac{J}{c}$, hence, can also be found by the aid of the tables in the accompanying Data Sheet Supplement, as it is apparent that J and $\frac{J}{c}$ are exactly double the values of I and $\frac{I}{c}$, respectively, for the same shaft diameters. This relationship is true only for circular cross-sections.

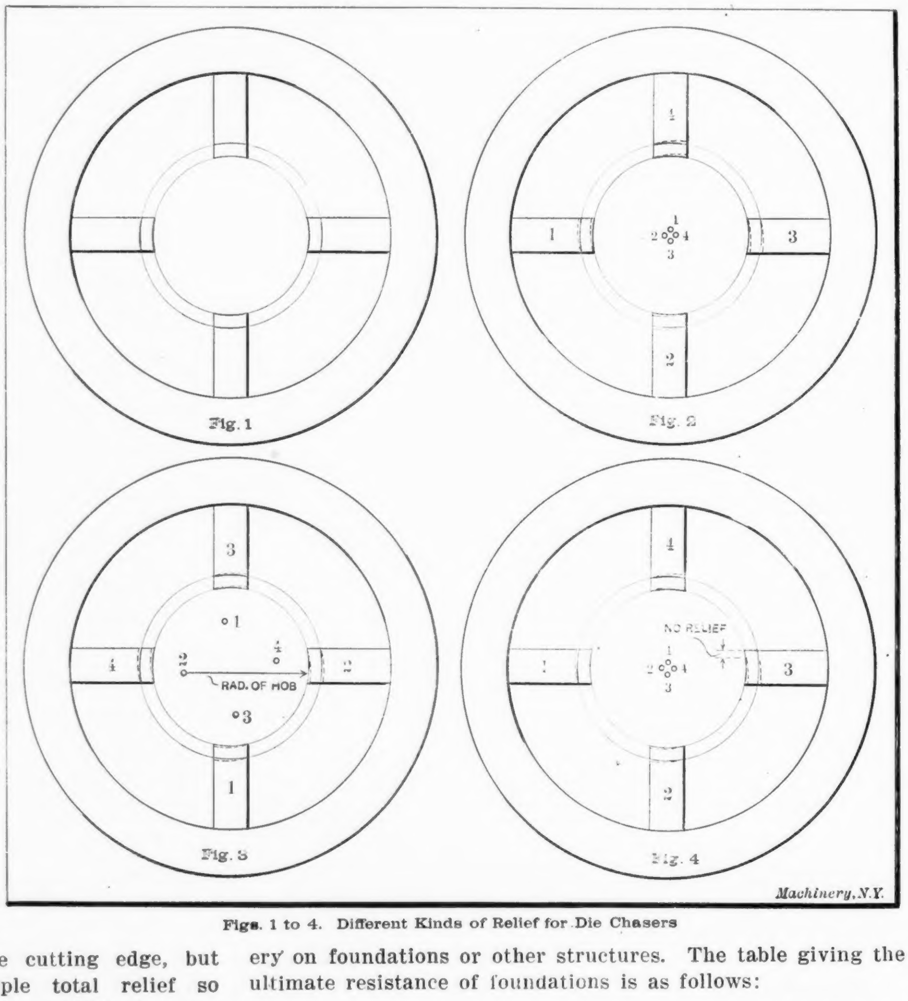
* * *

RELIEVING DIE CHASERS

By CORRESPONDENT

A proper relief on die chasers is very important if good cutting action and standing up qualities are to be expected. There are a number of methods by which die chasers may be relieved, some of which give no satisfaction at all and others of which give a reasonable measure of satisfaction, but the method advocated in the following is more satisfactory than any other known to the writer.

In Fig. 1 is shown a die with four chasers, the chasers having been milled with a hob of the same diameter as the thread to be cut, and with the center of the hob coinciding with the center of the die in which the chasers are inserted. In other words, these chasers have no relief. In Fig. 2 the dotted line indicates the appearance of a relieved thread in the chasers, the relief being obtained by using the same hob for cutting the chasers as was used in the case of Fig. 1, but with the center of the hob moved slightly toward one side with reference to the center line of the chaser, as indicated by the four small circles near the center of the die, each of these representing the center of the hob when cutting the chaser correspondingly marked. Relieving dies by this method gives a keen cutting edge, but there is too much relief back of the edge, and the chaser does not stand up in a satisfactory manner. The piece threaded is also likely to be out of round, unless the relief is very slight.



Figs. 1 to 4. Different Kinds of Relief for Die Chasers

In Fig. 3 is shown a method of relieving the chaser so as to produce a smaller relief immediately back of the cutting edge, but producing at the same time an ample total relief so as to permit the die to cut freely. This method also produces a stronger cutting edge. In this case the relief is cut with a hob of considerably larger diameter than the diameter of the thread to be cut, as indicated by the small circles, each of which represents the center of the hob when cutting one of the chasers, and which are marked with figures corresponding to those on the corresponding chasers. The center of the hob is, of course, moved slightly to one side of the center line of the chaser. This relief is preferable to the relief shown in Fig. 2, and may be considered fairly satisfactory.

In Fig. 4 is shown the method of relieving die chasers which is advocated by the writer. In this case the chaser is cut by a hob of the same diameter as that of the thread to be cut by the die, but the center is set over to such an extent that the relief does not extend clear to the cutting edge, but leaves a section equivalent to about one-quarter of the width of the chaser without relief. This gives the cutting edge additional strength and enables it to stand up for a considerable time without being dulled or losing its size. The relief provided is ample for clearance, and a free cutting chaser is provided.

Of course, the cost of the chaser becomes somewhat greater, as it is necessary to cut it twice, first with the hob center exactly on the center line of the chaser, and then with the hob moved over toward one side. In the other cases, one cut is sufficient, as the relief extends to the point of the cutting edge. So far as the writer knows, there are no chasers manufactured for the market on this basis, and it is necessary for anyone who wants to use chasers of this type to cut them himself.

* * *

ULTIMATE RESISTANCE OF SOILS AND ROCKS FOR FOUNDATIONS

In an article on "The Importance of Scientific Investigation" in the *Journal* of the American Society of Engineering Contractors, a table of the ultimate resistance of soils and rocks is given. While this table pertains more particularly to structural engineering, it may be of some value to machine erectors and others engaged in the setting up of heavy machinery on foundations or other structures. The table giving the ultimate resistance of foundations is as follows:

	Per square foot
Compact bed-rock granite or equivalent......	30 tons
Compact bed-rock limestone, Northern, sound	25 tons
Compact bed-rock sand-stone, Northern, red..	20 tons
Dry coarse gravel, well packed..............	6 to 8 tons
Soft friable rock, shales, etc..............	5 to 10 tons
Good solid, natural earth, dry..............	4 to 6 tons
Clays, in thick beds, absolutely dry	4 tons
Clays, in thick beds, moderately dry.........	2 tons
Soft clays	1 ton
Compact dry sand, well cemented............	4 tons
Clean dry sand, natural......................	2 to 4 tons

CINCINNATI BICKFORD TOOL CO.'S PLANT AT OAKLEY, CINCINNATI

The modern tendency to plan a shop so that the work can pass through it from beginning to end, and all the required operations be performed on it without the unnecessary moving of heavy pieces back and forth, is unusually well exemplified in the new plant of the Cincinnati Bickford Tool Co., located at Oakley, forty minutes out, by trolley, from the business center of Cincinnati, Ohio. The location of all the machinery and of the various departments in this shop was carefully planned before the shop was built, so as to insure that all details in the completed plant would meet with the requirements of economical manufacturing methods. It is the object of the following article to briefly describe the arrangement and main features of this plant.

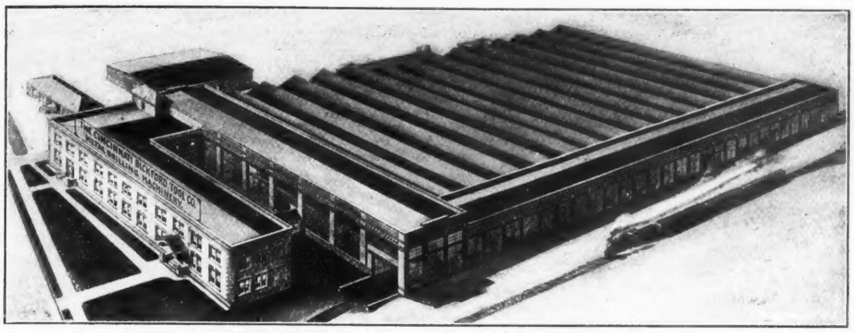


Fig. 1. Bird's-eye View of the Cincinnati Bickford Tool Co.'s Plant

The exterior of this modern manufacturing plant is shown in Fig. 1, while Fig. 2 shows a diagrammatical outline of the plant and the arrangement of the machinery in it. The plant is a one-story building with saw-tooth roof construction; only the office building and the adjoining ell containing the washroom and pattern-shop are two stories high. The general arrangement of the plant will be most easily understood by direct reference to Fig. 2. The shop building proper is 430 feet long by 165 wide. At each end of the shop there is a depressed track leading into it, this track connecting with a railroad track passing by the plant. The reason that one track has been led in at each end, instead of having the track pass straight through the shop along one side, is that floor space is saved by the adopted arrangement. The length that the tracks project inside of the shop at each end is 90 feet, which is ample for permitting two cars to come into the shop at each end at once; this is all that is required at any one time. The track is four feet below the level of the floor in the shop, so that the car floor will be level with the shop floor to facilitate loading and unloading. The track entering at the right-hand side in Fig. 2—the north end—is intended for incoming material, rough castings, bar stock, etc., while the track at the south end is intended for the shipping of finished machines. The whole shop has been laid out with the idea of having the incoming material pass through the various operations, in successive order, from the north to the south end, without unnecessary handling or moving back and forth.

The last bay toward the north end is set apart for a stock-room for rough material and for small parts made in the shop or bought from the outside. This stock-room is 28 feet wide and extends across the shop, as shown. The bay into which the car track enters runs lengthwise of the shop and is 35 feet wide. In this bay are placed the largest and heaviest machines, which take care of such heavy castings as require to pass through this bay only. It is equipped with a lathe for turning heavy drill press columns and sleeves, a boring machine for large castings, two planers and large radial drills. The remainder of the floor space in this bay is employed for assembling and testing the largest sizes of machines. The bay is served by a 15-ton Pawling & Harnischfeger cage-operated crane. The heaviest parts of machines can thus be removed from or placed upon the cars without difficulty, as the cranes go clear over the projecting railroad tracks and cars.

The material for small and medium sized parts is issued directly from the stock-room at the north end, a long counter

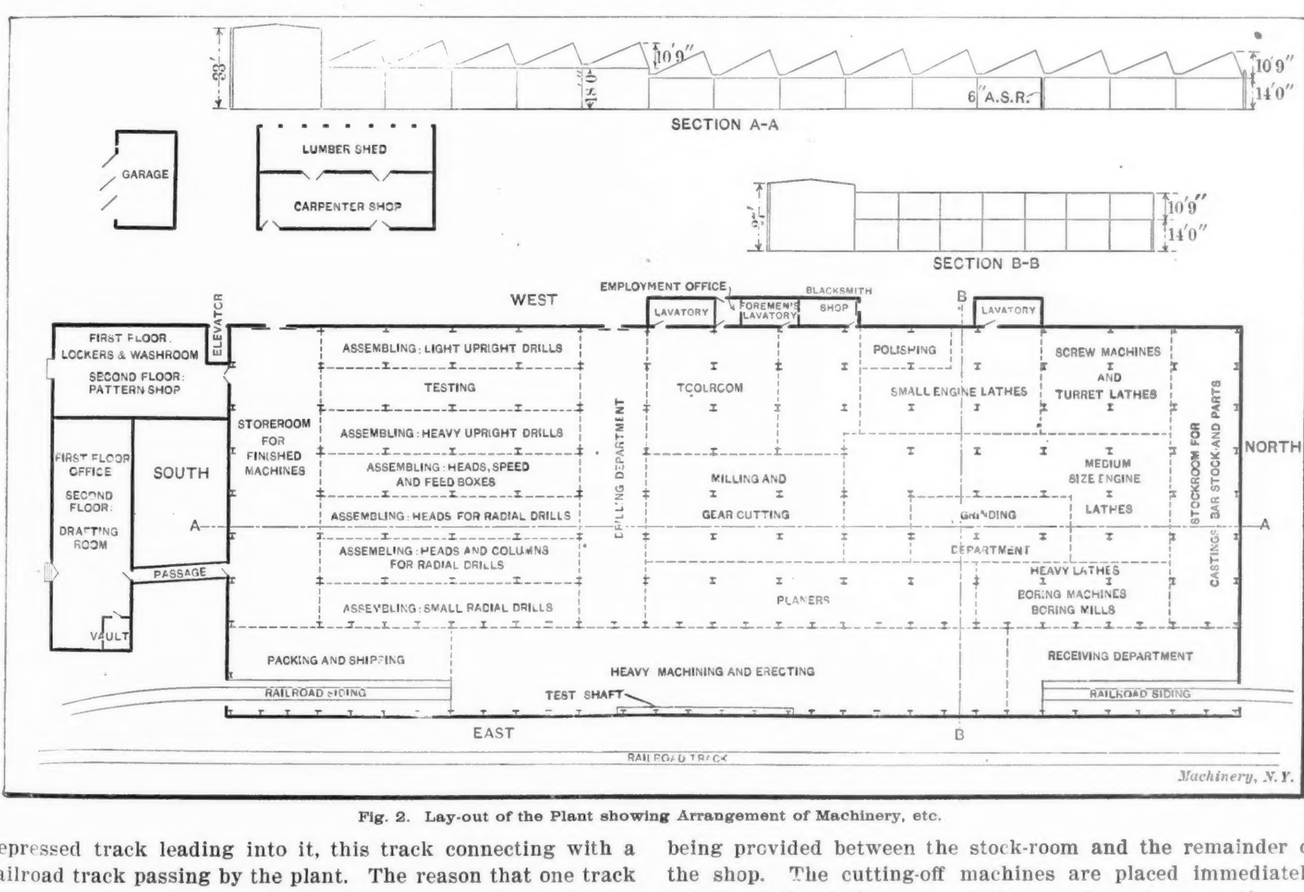


Fig. 2. Lay-out of the Plant showing Arrangement of Machinery, etc.

being provided between the stock-room and the remainder of the shop. The cutting-off machines are placed immediately outside of the stock-room, and the manufacturing operations on the parts begin in the space adjoining. The turret lathes for castings and the screw machines for bar stock are placed as indicated in Fig. 2 in a place close to the stock supply, so that the bar stock and castings go right from the stock-room to the machines. As the operation immediately following the turret lathe work on castings is often hand reaming, a bench for this purpose is provided close to the turret lathes. The reamers to be used are kept on the bench, so as to be handy

to the men, and every hole is tried with a steel plug after reaming, to insure that it is of the right size. If the reamers are found to be below size, they are returned at once to the tool-room for re-adjustment and grinding. Fixtures, tools and jigs are stored in several places throughout the shop, the idea being to keep each set of fixtures and tools close to the machines in which they are to be used, so as to save time in handling the fixtures and returning them to their respective places.

As turning operations are usually next in order, the engine lathes are placed immediately adjoining the turret lathes. In this department are also placed two turret lathes used exclusively for the making of bronze bushings. It should be understood that there are no partitions or obstructions of any kind between the various departments, the dotted lines in the engraving merely indicating the boundary lines between the space set apart for each class of machines. After the small parts leave the lathes they arrive at the grinding department which is next to the lathe department; parts which are not ground go to the polishing department. In the space adjoining the space set aside for these machines are placed the gear-cutting and milling machines; in this department are also placed the keyseaters and broaching machines.

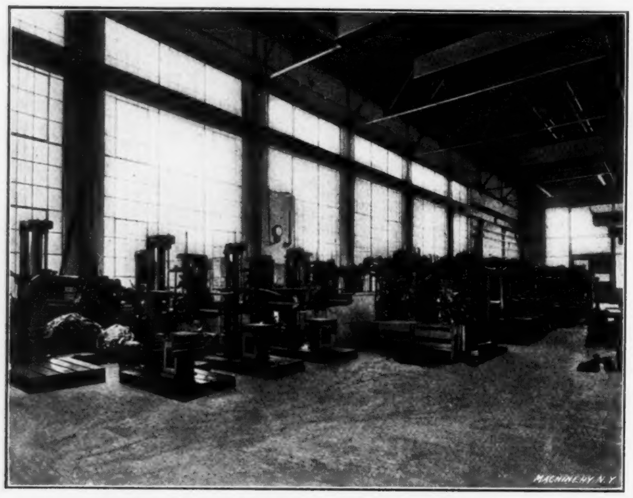


Fig. 3. South Bay—The Finished Stock-room

The right-hand end of the bay which adjoins the wide bay on the east side containing the railroad track, is equipped with machines suitable for medium-sized work. In this bay are placed heavy lathes, large grinding machines, boring machines, boring mills and medium and small sized planers. This bay is served by several small cranes.

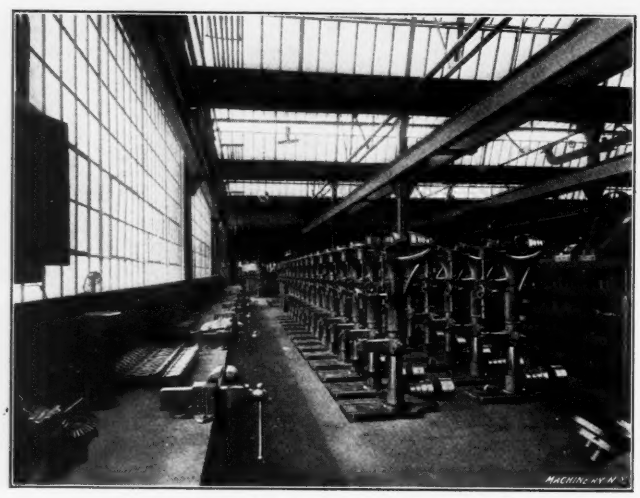


Fig. 4. Assembling Bay for Light Upright Drills

From these departments the work now goes to the drilling department, which is located cross-wise of the shop. From here the work enters the various erecting and assembling departments, all of which are indicated in the engraving. The south end of the shop contains seven bays running lengthwise of the shop, and one large bay running cross-wise, at the extreme south end. This large bay, shown in Fig. 3, is set apart as a store-room, in which the machines are placed after having been assembled and tested and while awaiting shipment. The first bay, from the west side, a view of which is shown in Fig. 4, is used for the assembling of the lightest upright drills made by the company. The third bay, Fig. 5, is used for assembling larger sizes of upright drills. The second bay is used for testing the machines assembled in both the first and third bays. As soon as the machines have been assembled in the first or third bays they are set back into the space in the second bay for testing, thus clearing the floor in the erecting departments, and permitting a new lot of machines to be assembled. All the assembling bays are provided with cranes for carrying the finished machines into the store-room at the south end. The fourth bay from the west is used for assembling heads and feed boxes for upright drills, and speed boxes for upright and radial drills, the machines being built strictly according to the unit system of construction. The fifth bay is used for the assembling of universal heads for radial drills, and the heads for large plain radial drilling machines. In the sixth bay small radial drill-heads are assembled, as well as back-gear brackets for large radial drills. In the seventh bay, shown in Fig. 6, and next to the large east bay (a part view of which is shown in Fig. 7) containing the railroad tracks, small radial drills are assembled, and the tables for large radial drills are fitted up. The small radial drills are tested where they are assembled, being driven from shafts which run lengthwise of the bay.

The large bay running cross-wise of the shop at the south end is 35 feet wide and is served by a 10-ton Toledo cage-operated crane. This bay is higher than the remainder of the shop, the object being to permit the 10-ton crane to run at such a height that all the cranes from the assembling floors will be able to run under and deliver work directly beneath the large crane. The tracks of the small cranes, therefore, project 7 to 8 feet into the large end bay. The 10-ton crane places the finished machine in position in the stock-room, to remain until shipment, at which time it loads it directly onto the car. This bay is of sufficient height for the crane to lift the machine vertically to such a height as not to interfere with the machines standing near, the lifted machine clearing the top of the other machines, so that it can be moved over them. One half of the store-room is devoted to upright drills and one-half to radial drills. A scale is provided in the east bay, near the track, where it can be conveniently reached either by the 15-ton crane in the east bay or by the 10-ton crane in the south bay. The crating for shipment is done in the space adjoining the track, and the location of the scale makes it convenient to weigh the machines at the time of shipment, both before and after crating, when required. The entrance of the railroad tracks into the shop is closed by means of vertical rolling steel shutters.

Fig. 5. Assembling Bay for Heavy Upright Drills

The tool-room is located at about the center of the shop on the west side, and covers a space of 56 by 48 feet. It is surrounded by a counter both at the front and sides, the space underneath the counter being utilized for racks or drawers containing the small tools. The tool-room is equipped with

grinding machines, lathes, drill presses, an arbor press, a shaper, and a milling machine. Two benches are provided, one for the making and adjustment of small tools, and the other for the making of jigs and fixtures, boring-bars, etc.

Adjoining the tool-room is a small employment office centrally located. The reason for locating the employment office in a central part of the shop is to make it convenient to take the applicant to the department in which he desires to work. The foreman of that department usually himself interviews the man to be engaged, and then recommends him to the general foreman if he finds him suitable for the work on which he would be employed. The sanitary arrangements are also centrally located, and a separate wash-room with lockers is provided for the foremen. The blacksmith shop is also located on the west side of the shop; here the tool dressing and light forging and casehardening is taken care of. The carpenter shop is located a short distance away from the main shop, near the south end, so that lumber for crating machinery, etc., can be brought straight from the shop through the stock-room to the shipping floor. The wash-room and lockers for the employes are located on the first floor of a two-story building at the south end of the machine shop, as is also the main office. The floor over the wash-room is utilized for the pattern shop, and on the second floor of the office building the drafting-room is located. A fire-proof vault running clear through the two floors in the office building is provided, the lower part

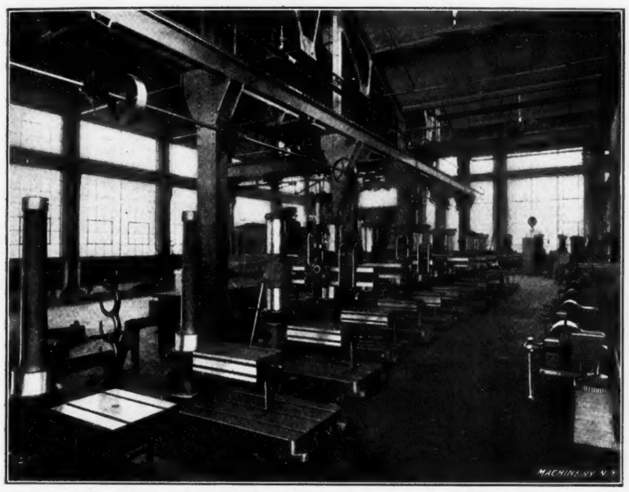


Fig. 6. Assembling Bay for Small Radial Drills

of which is utilized for the main office, and the upper part for the drafting-room.

The shop, as arranged, has a capacity for from 400 to 500 men, although at the present time its full capacity is not utilized, about 300 men being now employed. A comparatively small floor space is required for the efficient working of a comparatively large force when the shop is laid out systematically as described. The quantity of the product which can be turned out for an equal floor space is also greatly enhanced by the systematic planning of the shop.

Six line-shafts are provided for the machine tools, the line-shafts running north and south, and each having its own motor placed at a height of about six feet above the floor. The assembling floors are provided with motors for the line-shaft from which the machines are driven when tested, and from this line-shaft power is also derived for small machines used for fitting purposes. In all, there is about 1800 feet of line-shafting throughout the shop. Practically all the bearings in the line-shafts are Hyatt roller bearings. The power is derived from a central power station, located 500 feet north of the factory, in which the company owns an interest. Underground lead-covered cables carry the power to the northwest corner of the machine shop where the switchboard is located. The wiring in the shop to the motors is carried in conduits beneath the floor.

The shop is excellently lighted by 91 Cooper-Hewitt lights. The character of the lighting is well illustrated by the halftone Fig. 8, which was made from a photograph taken at night, with no other means of illumination than that provided by the regular lighting. The heating is provided for by a hot-water system of the Evans-Almiral type; the heating coils pass around the walls and overhead coils are also provided. The hot water is obtained from the power house mentioned, and brought to the shop in pipes laid in a concrete duct. Drinking water is provided for by six "bubbling" fountains, conveniently distributed throughout the shop.

The machine shop and assembling departments are of saw-tooth roof construction, the roof bays running from east to west. These bays, however, extend only to the south and east bays which are built independently of the regular saw-tooth roof construction. The distance from the floor to the trusses supporting the roof over the assembling floor is 18 feet, and

Fig. 7. East Bay—Part of Assembly Floor for Large Radial Drills

over the tool-room and machine department, 14 feet. Cast-iron hangers let down the stringers for the shaft hangers to a distance of 12 feet from the floor. This has been found to be the best height to give the proper length of belts for the machines. The reason for having the trusses in the machine shop two feet higher than the height required for the shafting is simply to provide better ventilation. The roof windows face north, the total length of the sash being 126 feet. The upper half of the sash swings out and is operated by a chain from the floor, the entire length of each sash being opened from one point. All the window sashes are of metal, and the roof is of reinforced concrete construction. The floor consists of 3-inch pine-

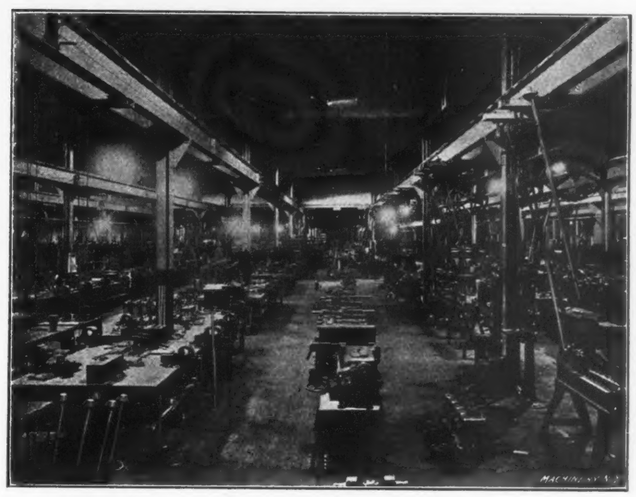


Fig. 8. Photograph taken at Night—Building illuminated only by Cooper-Hewitt Lamps

boards nailed to sleepers underneath, which are laid into a 5-inch layer of tarred concrete. The top of the floor consists of ⅞-inch maple. Overhead automatic sprinklers are provided throughout the shop.

As will be understood from the previous brief description, considerable care was exercised in the design of this plant, and as mentioned in the introduction, it was possible to arrange the shop in the manner indicated only by laying out in detail the location of every machine before the size and general arrangement of the shop building was finally decided upon. The building was designed by the firm of Dodge & Day, of Philadelphia, Pa., in conjunction with Mr. Schauer, vice-president and general manager of the Cincinnati Bickford Tool Co., and the machinery lay-out was taken care by Mr. Schauer and Mr. Shafer, the superintendent. E. O.

TYPES OF MILLING MACHINE BRACES

By FRED. HORNER*

The column-and-knee type of milling machine affords a curious instance of the persistent retention of a design that is admittedly faulty. The knee, which fits against one vertical face only, has, in this overhanging position, to sustain its own weight and that of the superimposed slides, the table attachments or jigs, or dividing heads, and to resist the pres-

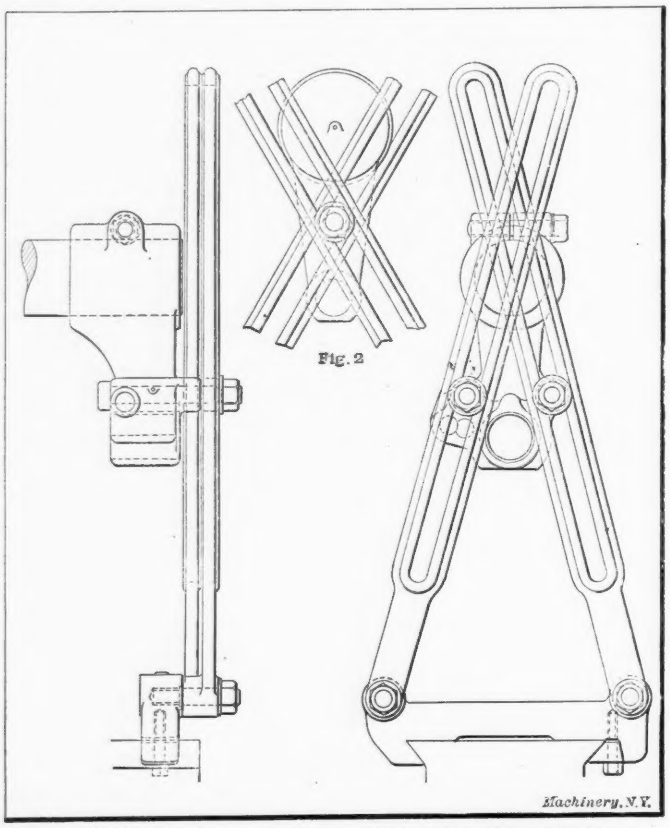


Fig. 1. Slotted Braces used on Brown & Sharpe Light Milling Machines. Fig. 2. Slotted Braces tied with a Single Bolt

sure of the milling cutter, without permitting vibration and chatter to occur. Yet the design, though unmechanical, is so useful that it cannot be supplanted by any other construction for the particular class of operations for which these machines are employed. If it were not for the fact that the knee must be capable of vertical adjustment, it would be easy

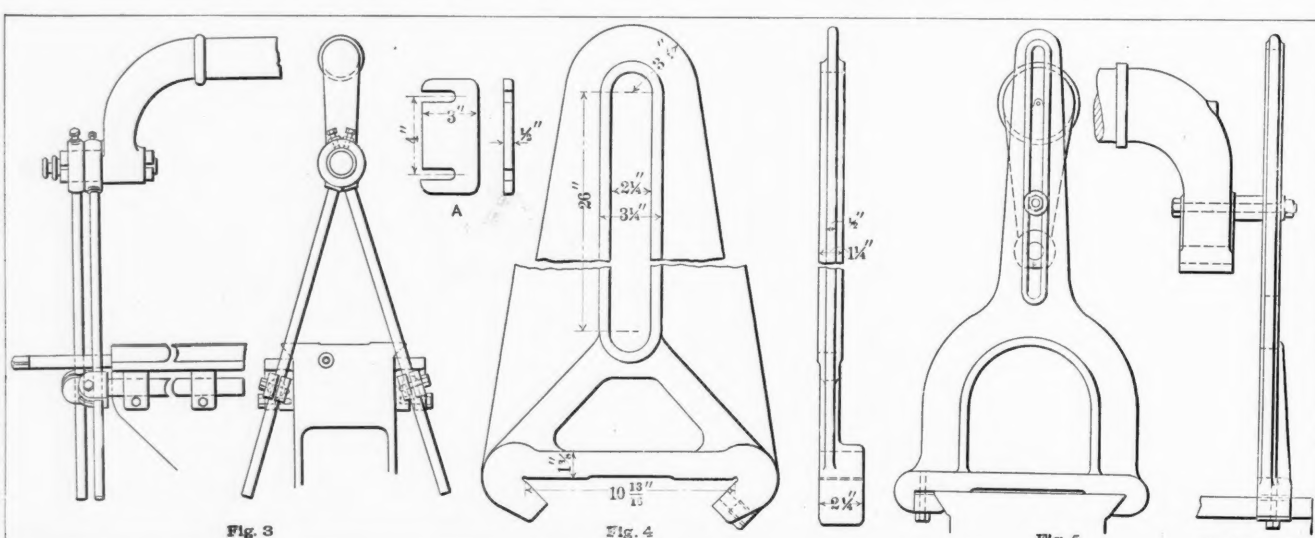


Fig. 3. Bracing made from Round Rods Fig. 4. Brace with Wide Central Slot Fig. 5. Arched Type of Brace

to provide a fixed bed underneath the longitudinal slide or table, but such a design at once greatly limits the range of the machine, and is only suitable for manufacturing operations of a repetitive or plain character.

The alternative to a movable knee is that of an adjustable spindle, moved up or down by its slide, but there are so many objections to this construction that it is but little employed. For the sake, therefore, of the great handiness of the column-and-knee machine, its defects are tolerated, and the inherent weakness is, as far as possible, compensated for by the employment of bracings, which tie the knee and the overhanging arm together, and also steady the outer bearing of the arbor. Such bracings naturally interfere to a certain extent with the operator's view of the work, and with the manipulations which have to be made; while for vertical feeding the bracing must be loosened. The inconvenience caused by the obstruction of the bracing is decreased in certain designs, either by adopting a perforated type of brace, or by placing it to one side, thus leaving the front fairly free of access. The latter type also favors the work being placed on the table with a portion projecting out at the front, as would

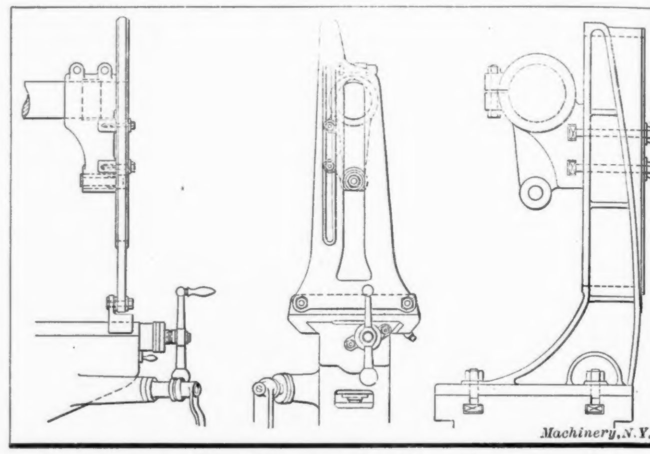


Fig. 6. Brace with Bolt Slot set to One Side. Fig. 7. Example of Brace set to One Side

be necessary when milling the foot of a pillar or bracket. As most of the intricate and difficult milling is frequently done on comparatively small and light pieces, the brace can be removed, when all objections vanish.

The easy adjustment and removal of a bracing is an important factor in machines where milling of a varied and frequently-changing class is done, and it will often be noticed that the lighter machines have their bracings secured by one or two bolts only, while the heavier types require four bolts in many instances to lock them to the arm and arbor support. This happens to harmonize both with the nature of the work done—light and heavy—and with the desired convenience of manipulation, since a small machine is subject to more frequent changes of work than a large one, which may continue on one class of operation or on long pieces for a considerable time.

The most popular type of brace which has been used in the past is that which is composed of two slotted bars or links,

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crossed over each other, and secured to the knee by a stretcher clamp, and to the overhanging arm with one or two bolts. This is a handy design, easily manipulated, light to handle, and causing but little obstruction. It does not, however, provide such a stiff construction as certain other types of bracings, and it is, therefore, largely superseded on designs of recent date, some firms having abolished it altogether on their machines, while others use it only on the smaller sizes of millers. The slotted arm is also in some instances made of increased width and material, as in the machines made by Kearney & Trecker Co., Milwaukee, Wis., and other machines of a similar type, the object of which is to resist the tendency to spring which such slotted bars exhibit.

Fig. 1 represents a typical bracing of the slotted-bar type, as used on one of the lighter styles of machines made by the Brown & Sharpe Mfg. Co., Providence, R. I. The bars are pivoted on studs set into the knee clamp, which is secured by a wedge gib, and a couple of bolts passing through holes in the center-arm head bind the braces to this. In some designs of machines the two bolts passing through the arbor head are replaced by a single bolt, as shown in Fig. 2. This type though more rapidly manipulated than the other, does not afford such a good resistance to lateral motion of the arbor support. Sometimes a handle takes the place of the single nut, to avoid the necessity of using a spanner.

Another variation is that of inserting a bolt at the point where the braces cross as shown in Fig. 1, and binding them together with it, so as to provide a little additional security. It will be seen that the reason for separating the braces in this design, is not only to better resist the lateral or "ricking" tendency of the arbor support, but also to leave a clear opening for the passage of the arbor, should this happen to be extra long. When the braces cross as shown in Fig. 2, the projection of the arbor is prevented.

It is generally accepted that round bracing rods are distinctly unsuited for resisting vibration, unless they are made of abnormal proportions, and then a rectangular section meets the condition quite as well. It may be interesting, however, to illustrate one example of the use of circular rods to form a bracing. A bracing of this type is shown in Fig. 3, and is used on a German milling machine. The top end of each rod is enlarged into an eye, which fits over and is locked by a set-screw to the extension on the overhanging arm. A round rod on each side of the knee, clamped in split lugs, has a split lug at its end to hold the brace rods, so that adjustments in vertical and horizontal directions are possible.

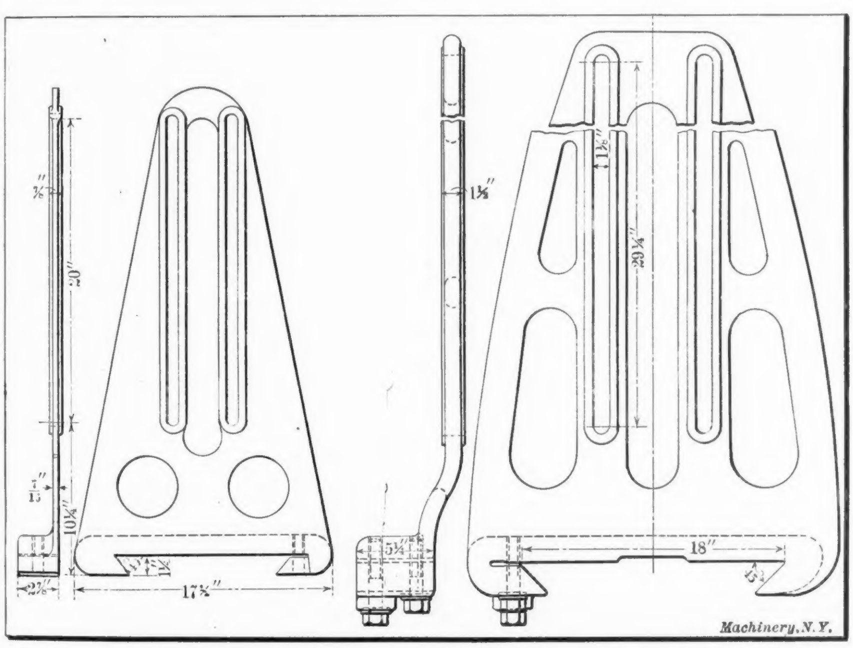


Fig. 8. Brace used on the Hendey Miller. Fig. 9. Example of Bracing bent outward

Coincident with the general stiffening and improvement of milling-machine frames, and particularly of the knees, there has been a general movement in favor of the adoption of braces which are of wide and stiff form, well ribbed or webbed, so as to present the best possible resistance to vibration. A good many variations in design are extant, a few of which will be illustrated and described in the following: These webbed braces may be divided into two classes, those with a single vertical slot, and those with two vertical slots, the latter being in the majority. A brace with a single slot, used on the milling machines built by the Oesterlein Machine Co., of Cincinnati, O., is illustrated in Fig. 4. It will be seen that the slot is wide enough to let the heads of the clamping screws (which tie it to the arbor support) pass through. A clamping plate *A* is slipped on under the screw heads, to press on the face of the brace. It is only necessary, therefore, to slide this plate away, when the brace can be pulled off without taking out the two bolts.

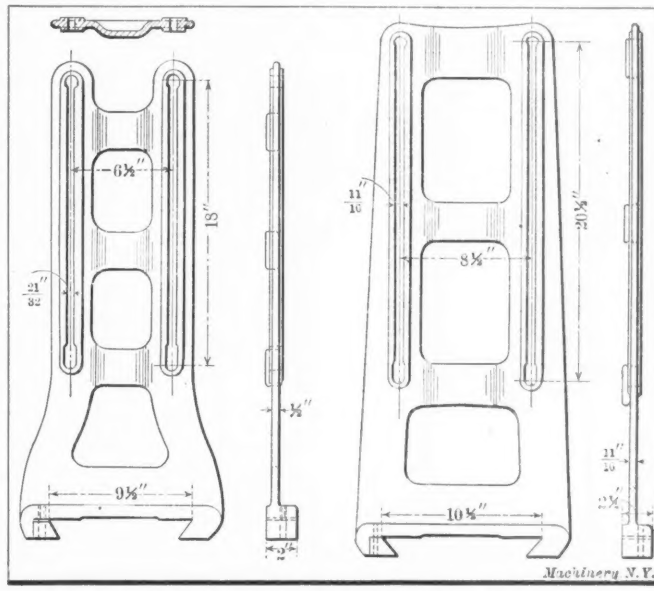


Fig. 10. Brace with Central Web bent outward. Fig. 11. Another Brace with Central Web bent outward

Fig. 5 is an English design of brace, of arched form, which is tied with one bolt to the curved end of the overhanging arm. Other variations might be illustrated, but they differ but little in form from that shown. The objection to the single central slot of normal width, is that the arbor support hole is obstructed by the brace; the only way of avoiding the difficulty is either to widen the slot, as in Fig. 4, or to adopt the arrangement illustrated in Fig. 6. This is the style employed on the line of plain and universal millers constructed by Messrs. J. Parkinson & Son, of Shipley, Yorkshire, England. In this type there is a clear wide slot down the center, so that the cutter arbor may pass through, and the adjusting bolt for the split-arbor bush be manipulated. The clamping slot is set to one side, and the screws pass through the lugs cast on the side of the arbor head.

The heavy millers made by the Hendey Machine Co., Torrington, Conn., have a wide brace of the form shown by Fig. 8. In this type there are four lugs on the arbor head, so that two screws fit in each slot. The R. K. Le Blond Machine Tool Co., Cincinnati, O., employs a wide type of bracing, as shown in Fig. 9, which is distinguishable by the fact that it is bent outward, as shown in the side view, so as to leave the maximum possible amount of space from the arbor support to the face of the column. Mention might also be made of the method of clamping the brace to the knee, the spring of the metal being utilized instead of fitting the usual separate gib strip. It will be observed that one screw is set lower than the other,

for convenience in using the spanner, as the heads happen to come close together.

The Owen Machine Tool Co., of Springfield, O., bends out the central webs of its braces, as shown in Figs. 10 and 11, the object of which is to gain a little clearance for the arbor head. The two illustrations show the smaller and larger sizes, respectively. Fig. 12 shows a brace taken from a German milling machine. It is rather elaborately ribbed, but the chief point about it is that it cannot be attached to the knee in the usual manner (on the edges of the ways), because the saddle is extended out to pass over the knee. The brace is, therefore, attached to facings on the sides of the knee, a limited amount of adjustment for the brace being provided by slots, as shown in the view to the left. The details of the operating screws and handles are omitted for clearness.

The Cincinnati Milling Machine Co., Cincinnati, O., employs a very effective type of brace shown in Fig. 14 on its heavy millers. The top of the brace is bored to embrace the steel arm, and two holes receive bolts which pass through them into the arbor support *A*. The clamp *B* is secured to the knee, and screws passing through the slots in the brace bind the latter to this clamp. This truss form of brace may be rendered more rigid when the knee happens to be set low

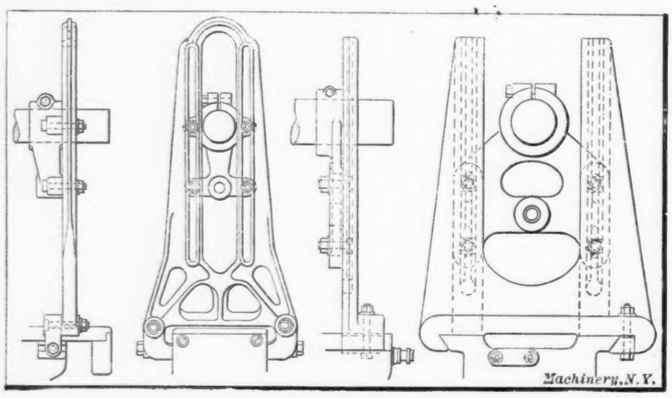


Fig. 12. German Example of Ribbed Brace. Fig. 13. Stand and Slide Brace with T-slots

by the addition of a diagonal brace *C*. The Cincinnati Milling Machine Co., in a letter relating to this brace, says:

"Our experience has convinced us that on a horizontal milling machine of the column-and-knee type, when doing ordinary work with a spiral milling cutter on an arbor, the pressure against the outer arbor support is approximately in line with the table travel. In other words, this bearing is subjected to tremendous side pressures. The vertical pressures are not so great. In fact, if the cut is of any considerable depth, the vertical pressure amounts to practically nothing,

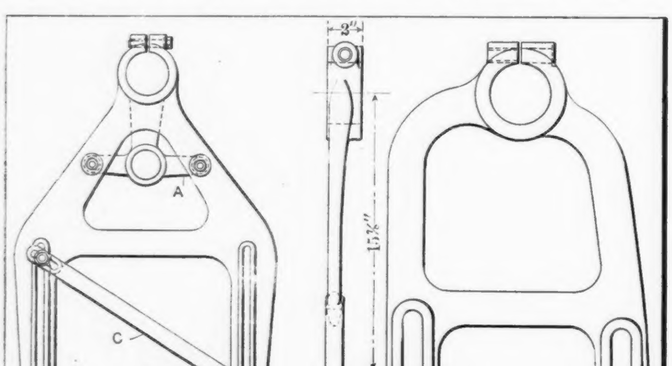


Fig. 14. Truss Form of Bracing. Fig. 15. Brace with Curved Slots

and in fact, it may be negative on account of the lifting action of the cutter. In view of these facts, we have designed the brace, for supporting the outer arbor bearing, especially for stiffness against these side pressures, and our experience with this form of brace has proven most satisfactory indeed."

Although straight slots are the rule in practically all braces used on ordinary millers, there is one exception, which occurs in a certain type of Brown & Sharpe plain machine. This has its cutter spindle adjustable vertically to a limited extent, and the one slot in the brace is curved as shown in Fig. 15, to accommodate the radial movement when the spindle is adjusted. Owing to the particular movement which takes place, one slot need not be so long as the other.

The double type of brace, Fig. 16, which is used on the

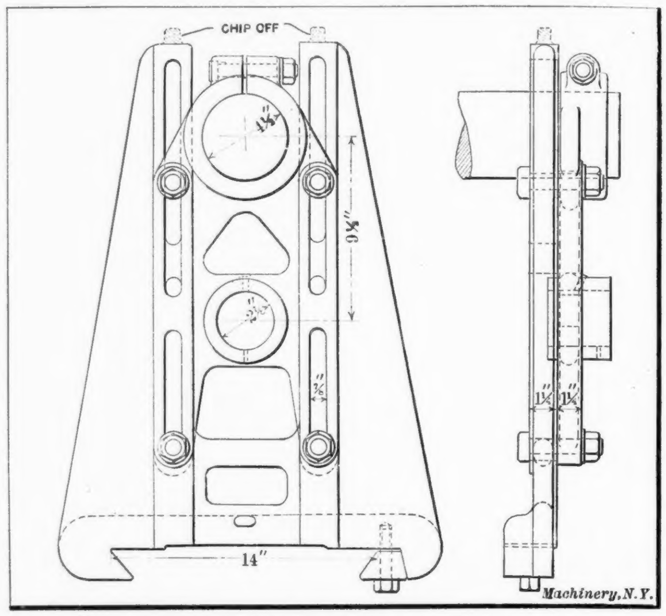


Fig. 16. Stand and Slide Type of Bracing used by Brown & Sharpe Mfg. Co.

Brown & Sharpe heavy machines, constitutes a very rigid arrangement, there being ample bearing surface, and four bolts to bind the two portions together. By this construction an extra arbor support is afforded in the sliding part, so that the regular arbor head can be slipped along the arm to any position, for use as an intermediate bearing when using gangs

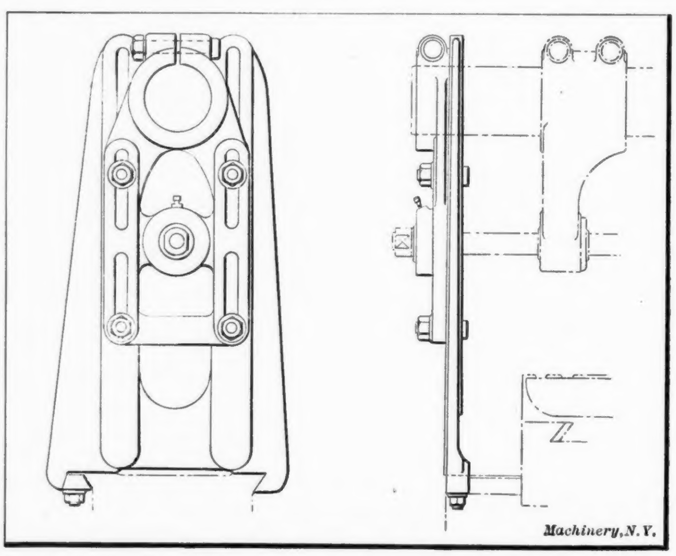


Fig. 17. Stand and Slide Type of Bracing used by Alfred Herbert, Ltd.

of cutters. Fig. 17 illustrates a similar type of brace made by Messrs. Alfred Herbert, Ltd., of Coventry, England, the parts of the machine being shown in dotted outline.

The Schweizerische Werkzeugmaschinenfabrik Oerlikon, Oerlikon, Switzerland, equips some of its millers with a brace as shown in Fig. 13. It will be seen that the principle is similar to that shown in Figs. 16 and 17, but instead of open slots in the fixed stand, T-slots are made, which affords a little more rigidity. Fig. 18 represents the same firm's open-slot design of bracing, the split boss of which grips the turned extension on the bent arm, so that it is unnecessary to have a second bearing-opening in the brace. Both of the braces manufactured by this company are made from steel, instead of cast iron.

Several machines which emanate from Europe have braces or steady-brackets modeled after the style shown in Fig. 19, with various modifications in detail. A T-slot runs up the face of the bracket, and a couple of bolts stand out to clamp the arbor head firmly against the bracket. As previously mentioned, this type of brace possesses advantages from the point of view of accessibility, and inspection of the cutter and the work. By making it of ample strength, the objection

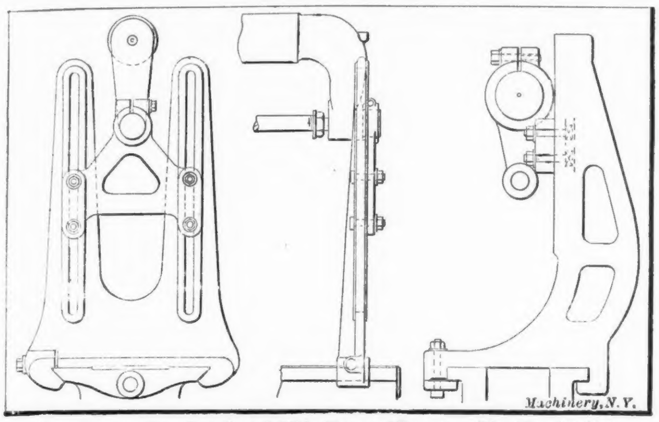


Fig. 18. Another Stand and Slide Type of Brace. Fig. 19. Another Example of Brace set to One Side

to its one-sided character is greatly minimized. Frequently, instead of bolting the actual arbor head to the brackets as in Fig. 19, a simple split bearing, Fig. 23, is employed, and the arbor head is situated further along the steel arm. Alternatively, when the overhanging arm is cast with the arbor bearing in its bent end, the straight portion of the arm is prolonged to reach to the split bearing.

Fig. 7 shows a different design of bracket, in which the bolt

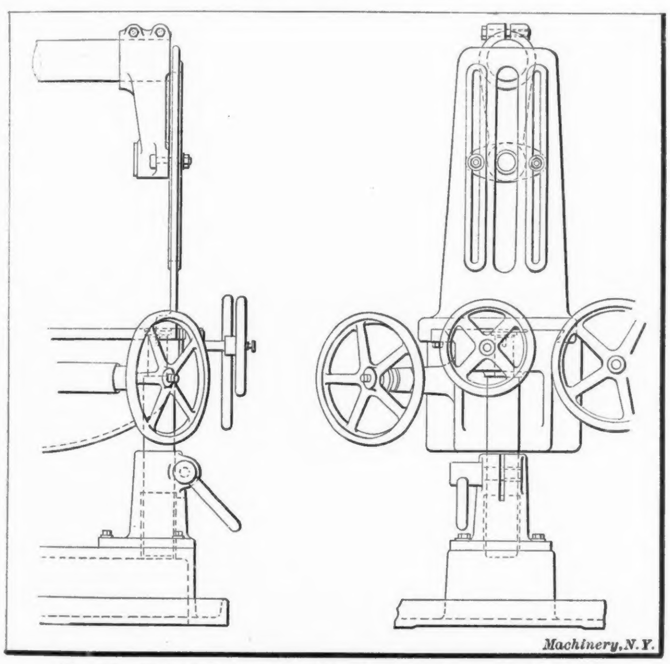


Fig. 20. Slotted Brace in Combination with Support under Knee

slot is cored through the frame, the heads of the bolts entering into T-slots in the arbor head. These T-slots are prolonged for a few inches to permit of adjustments to accommodate arbors of different lengths. The bracket, as will be noticed, is clamped to the knee by a pair of bolts entering into T-slots on the top face of the knee.

Knee Supports

We now come to the consideration of a different class of bracing, where more complete and effective support is afforded to the knee. This is done by obtaining a support from the base or foot of the framing, instead of depending upon the overhanging arm alone. It may be argued, with some degree of truth, that the elevating screw of the knee helps to support the latter against downward deflection; but it cannot be of much assistance in preventing vibration, or lateral twisting movements. Therefore, we find that several firms in Europe prefer to give the knee adequate support by some form of bracket or brace standing up from the foot, and either independent of the upper arm brace, or combined with it. The chief objection to the independent support is the extra complication, and the necessity for tightening and loosening several bolts each time the support has to be released for the purpose of adjusting the knee up or down. This, however, is largely a question of how often the changes are likely to be wanted; in some machines the work is of a fairly constant character, notably in certain types used for repetition work, and for gear-cutting, and the objections to having to loosen and tighten a number of bolts are not so important.

The favorite form of support beneath the knee is that of a bracket bolted to or cast with the knee, sliding against a

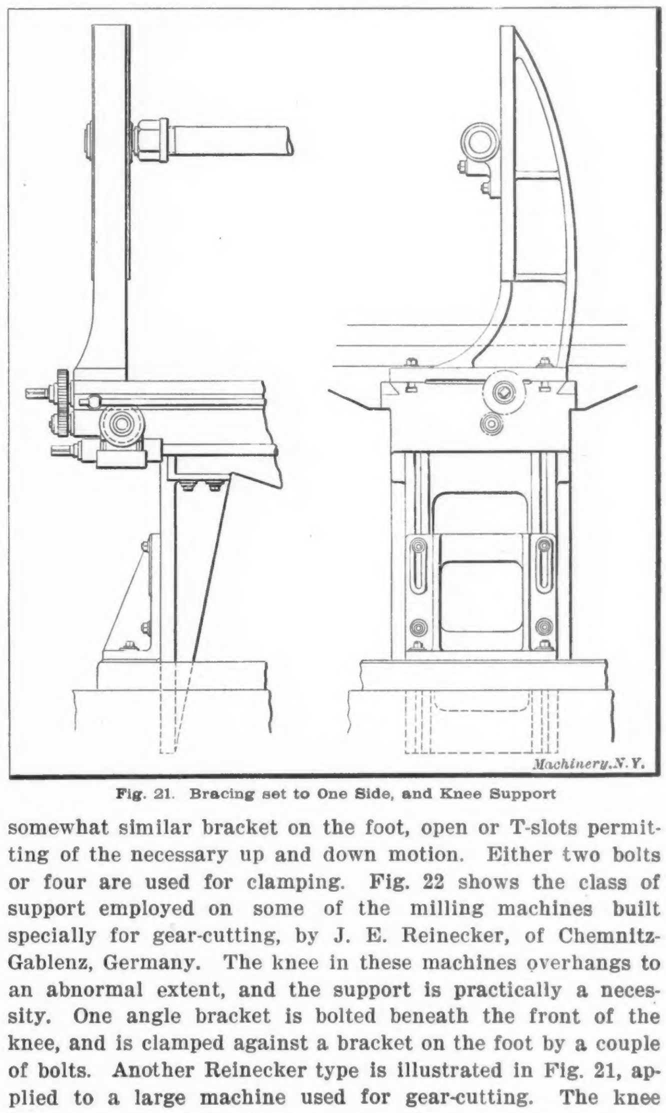


Fig. 21. Bracing set to One Side, and Knee Support

somewhat similar bracket on the foot, open or T-slots permitting of the necessary up and down motion. Either two bolts or four are used for clamping. Fig. 22 shows the class of support employed on some of the milling machines built specially for gear-cutting, by J. E. Reinecker, of Chemnitz-Gablenz, Germany. The knee in these machines overhangs to an abnormal extent, and the support is practically a necessity. One angle bracket is bolted beneath the front of the knee, and is clamped against a bracket on the foot by a couple of bolts. Another Reinecker type is illustrated in Fig. 21, applied to a large machine used for gear-cutting. The knee bracket is placed in the opposite manner to that shown in Fig. 22, and has to pass down through the foot of the framing. The end of the arbor (which carries the blank) is supported

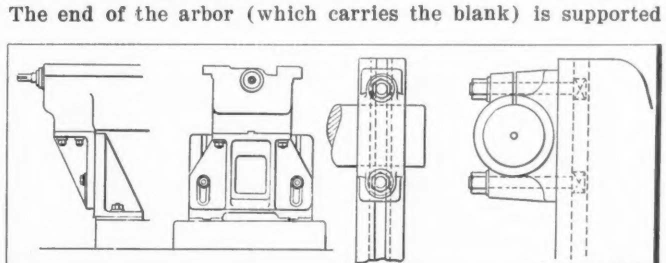


Fig. 22. Typical Support for Knee. Fig. 23. Split Bearing for Clamping Overhanging Arm

in a bearing, bolted against the steady brace, which is fastened to the top of the knee.

A very simple and neat knee support is adopted by Messrs. Greenwood & Batley, Ltd., Leeds, England, in which only a single handle has to be tightened and loosened, so that one of the objections to these supports is considerably minimized.

As shown in Fig. 20, a stout steel prop is shouldered into the knee, and held by a screw and washer. The prop passes down through a split bearing bolted onto the base. Although the knee projects out in this machine to a greater distance than usual, the support compensates for the overhang, and provides a rigid and easily altered fitting. A stiff webbed brace also connects the top of the knee to the arbor support.

These braces which extend from the foot right up to the overhanging arm, necessitate an extension of the base to a distance sufficient to provide an anchorage, and advantage is sometimes taken in this design to increase the length of the knee from the column to the outer end. The brace affords a rigid fastening, and supports the knee well besides tying it to the arm. In this type there is usually only a

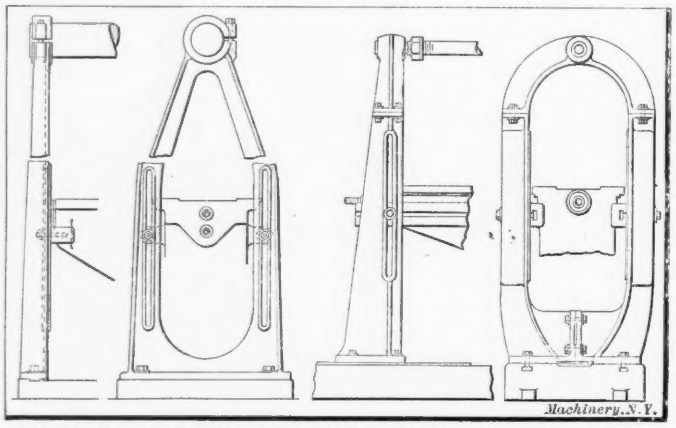


Fig. 24. Brace uniting Base, Knee and Overhanging Arm. Fig. 25. Loop Form of Bracing uniting Base, Knee and Work-arbor

couple of bolts to manipulate. A brace built by the Schweizerische Werkzeugmaschinenfabrik Oerlikon of Oerlikon, is shown in Fig. 24. This brace is bolted to the base, and is secured to the knee by a couple of screws. It continues up to the steel arm, to which is it clamped by a split lug. The arbor support is located further along the arm, and the brace remains in position during all the operations. A knee about 25 to 30 per cent longer than usual is fitted to this machine.

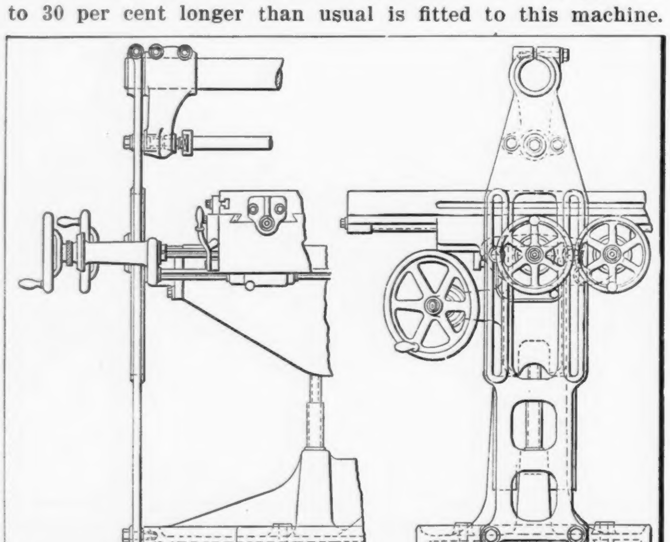


Fig. 26. Another Type of Brace uniting Base, Knee and Overhanging Arm

Some of the Reinecker machines used specially for gear-cutting are fitted with a loop design of brace, as shown in Fig. 25, comprising three sections bolted together. T-slots on the sides of the long knee receive the tightening screws, and the work arbor runs in the bearing at the top of the arch. T-slots in the base provide for a certain amount of adjustment to and from the column, and a rack and pinion device (not shown) is included when the weight of the brace renders other methods of moving it along the base difficult.

The last example, shown in Fig. 26, is taken from a plain milling machine built by H. W. Ward & Co., Ltd., of Birmingham, England. The upper part of the brace is designed to clamp the overhanging arm, and two screws also secure the arbor head, when the latter is brought out in contact with the brace.

METHODS OF TESTING TOOLS

During the last few years a great deal of creditable work has been done by various firms and individuals in order to determine the relative values of different kinds of materials used for making metal cutting tools, and different methods used in their manufacture. The methods of testing such tools—lathe tools, taps, twist drills, etc.,—may be divided into two distinct classes. In one case the tools are tested "to destruction," by employing excessive cutting speeds and feeds, and noting the time required to break the tool or entirely ruin its cutting edge. In the other case the tools are tested under actual working conditions, using such speeds and feeds as are suitable in everyday practice, and noting either the time elapsing between regrindings or the amount of work performed by the tool before its cutting edges are dulled.

There may be instances when it is desirable to determine the conditions under which a tool will break or otherwise become useless for further service, but as a rule it is safe to say that the more valuable and conclusive tests are those made under ordinary working conditions. There has as yet been no relation established between the time or stress required for breaking a tap or drill, for example, and its cutting qualities when used under regular shop conditions. Especially in the case of drills, it is, indeed, reasonable to assume that the drill which may break first in a comparative "destructive" test, would be the drill which, if used with reasonable care and not subjected to excessive stresses, could keep its cutting edge the longer and produce more work in a given time than the tool which in a destructive test might have seemed the better. Furthermore, drills and other tools are not intended to be used under conditions where breakage is imminent; in fact, any such usage is wasteful and any gain in production due to excessively forced speeds and feeds is more than likely offset by the increased cost of replacing broken tools. Hence the rational test of tools would seem to be a test in which, as far as possible, normal working conditions are duplicated, and in which the governing factors are so selected as to permit the tool to produce a maximum of work with the least possible chance of breakage.

This last method of testing tools has been thoroughly applied by the Union Twist Drill Co., Athol, Mass., in making comparative tests on twist drills. In order to make the tests as conclusive as possible, a very uniform grade of steel, 0.90 per cent carbon, is used for the test blocks to be drilled. These test blocks are 24 inches long, 6 inches wide, and 2¼ inches thick. The tests are made in a drill press of very strong construction, so as to eliminate, to as great an extent as possible, the tendency to spring the drill press frame out of shape and thus break the drill. A row of holes is then drilled by one of the drills to be tested, and another row immediately beside the first by the drill to be compared with the first. Then a row of holes is again drilled by the first drill, and one by the second, and so forth. The object of alternating the drills is to make allowance for any possible lack of uniformity of the metal at various parts of the test block. The tests are continued until each of the drills has been drilled and reground six times, and at the end of the sixth series of holes, the total number of inches that has been drilled by each drill is summed up and the results compared. It is understood that these tests are comparative only, but as fair a comparison as can well be imagined is made between different kinds of drills; and the test is made under the very conditions met with in regular shop practice.

The only reason why tools of this character should be tested to destruction would be to determine the factor of safety which they have when in use. This, of course, constitutes a useful and highly valuable test; but it does not give a clew to the relative cutting properties of the tools when used under normal conditions. It would seem that the reason why so many "destructive" tests are made on small tools is simply because the tools are so cheap that it is feasible to subject them to such tests. A boring mill, or a steam engine, is not subjected to destructive tests; yet, to thus test them would serve practically the same purpose—or lack of purpose—as the majority of destructive tests on cheaper appliances.

TRAINING OF MACHINISTS IN THE TRADE SCHOOL*

By JAMES A. PRATT†

The teaching of a trade in a school involves two fundamentals: First, the boy must be given a thorough training in all phases of the trade; and second, it should be so imparted that he will complete his course with a feeling of self-respect as well as a belief in his calling. If the school which devotes full attention to teaching a trade does not do the first, it fails in its purpose, while the young mechanic who does not regard his calling as worthy of his esteem, will not follow it to his own benefit or to that of the community in which he lives.

Quality of the Product

The school properly managed, which has three full years of a boy's time, between the ages of 16 and 21 years, has no

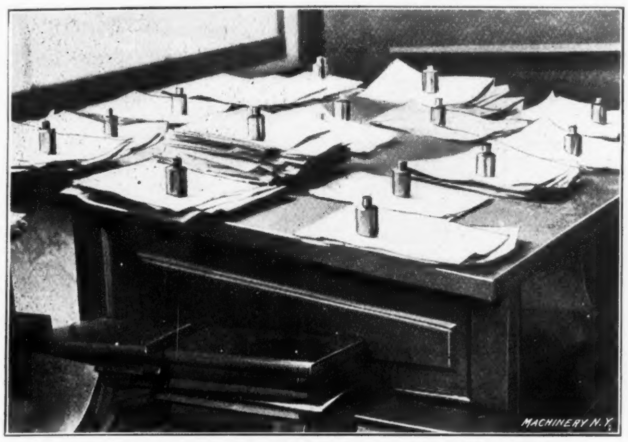


Fig. 1. Orders for Each Machine filed on the Order Section of the Instructor's Desk

reasonable excuse for sending from its doors, anything but well trained, intelligent and efficient mechanics. To do this, however, the officers and teaching staff must believe in each other, be practical teachers, apply efficient methods of work and have a supreme desire to teach trades. This sounds like a broad demand, but as a matter of fact, these requirements are not in any way beyond the possibility of fulfilment. The machinist's trade at Williamson is taught with these fac-

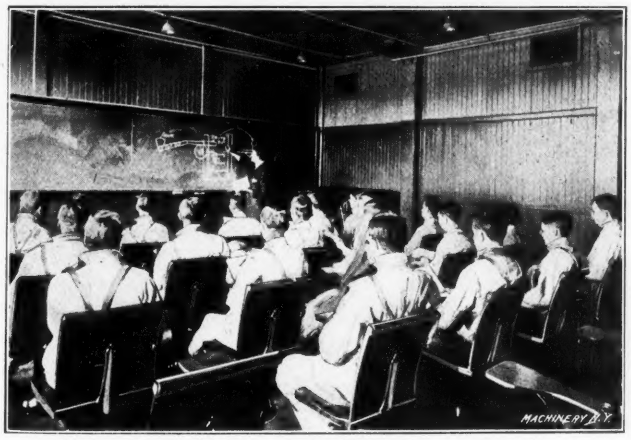


Fig. 2. Class-room Scene during Shop Talk on a Gear-shaper Mechanism

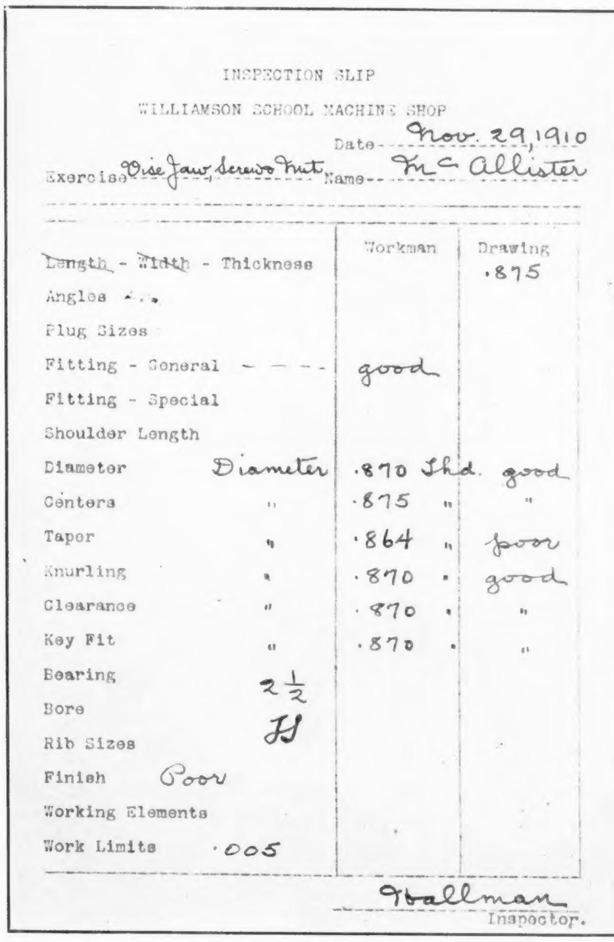
tors under consideration, and the results to be mentioned later warrant the claim that an excellent variety of journeyman is produced.

Purpose of this Article

The aim in presenting this article is to give an outline of the method followed in producing a mechanic in an organization where the skilled worker is the only product; there are no detracting influences, and the management devotes as much attention here to the efficient development of the apprentice as does the directing force of the industrial plant to the economical production of high-grade material articles of commerce. Time cards, cost sheets, manufacturing methods, jigs and fixtures are made and used, to lessen time and cost incidentally, but primarily to make the apprentice familiar with them, that he may have control of himself, in his many different connections with the industrial world as a mechanic. After he has become familiar with the particular system in use at the school, he has explained to him other systems to be found in various plants, and the proper attitude which he must maintain towards such accessories of a producing organization. In using jigs and fixtures, their purpose in the plant is explained, and the points to be observed in setting and handling are made clear, the intent being to teach the apprentice the possibility of seeing errors ahead and thus avoiding the loss of work.

Notes on the System Used

The shop system is such that not only are results in work obtained, but at the same time the boy receives a consecutive,



INSPECTION SLIP

WILLIAMSON SCHOOL MACHINE SHOP

Date Nov. 29, 1910

Exercise Vise Jaw, Screw Nut Name Mc Allister

		Workman	Drawing
~~Length~~ - ~~Width~~ - Thickness			.875
Angles			
Plug Sizes			
Fitting - General		good	
Fitting - Special			
Shoulder Length			
Diameter	Diameter	.870 Thd.	good
Centers	"	.875 "	"
Taper	"	.864 "	poor
Knurling	"	.870 "	good
Clearance	"	.870 "	"
Key Fit	"	.870 "	"
Bearing	$2\frac{1}{2}$		
Bore	JJ		
Rib Sizes			
Finish	Poor		
Working Elements			
Work Limits	.005		

Hallman
Inspector.

Fig. 3. Job Inspection Slip for Inspecting and Grading Quality of Work

well ordered training. The whole trade is taught on the exercise basis, some exercises being abstract and some concrete. A piece of work is regarded as an abstract exercise when it serves no other purpose than the training of the apprentice; it is a concrete exercise, when in addition to serving as a means of instruction, it is put to use in a machine or some piece of equipment about the school.

Whether the exercise is abstract or concrete makes no difference in the method of handling it in the shop, as all the day work in the plant is carried on under the factory system; that is, each boy is trained as an operator of one machine, then of another, and so on, taking the proper section of exercises at a particular time on each tool or at the bench. The apprentice does not remain at the machine or bench until *all* of the exercises have been finished, but until a *section* of the exercises has been finished. These sections are divided into: First, elementary; second, speed; and third, ad-

* For additional information on this and kindred subjects previously published in MACHINERY, see: "Education and Development of the Apprentice," December, 1910, engineering edition; "The Development of Machinist Apprentices," October, 1910, engineering edition; "McKinley Manual Training School, Washington. D. C.," January, 1910. "Educating Apprentices at Drifton," February, 1909, engineering edition; "The Fitchburg Cooperative Industrial School Course," October, 1908; "Evening School of Trades—Rindge Manual Training School, Cambridge, Mass.," July, 1908; "The Lawrence Industrial Trade School," December, 1908, engineering edition; "Education for Industrial Workers," September, 1907, and other articles there referred to.

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vanced. This applies to each machine. The beginner always commences at the bench, doing enough exercises to gain control of himself, to become accustomed to accuracy, and to eliminate the tendency to nervousness which is always an element of the untrained or poorly trained person's experience, when in an untried position.

There is no fixed time in which all the pupils finish these elementary exercises, different boys taking different periods of time; but the average season at the bench, previous to taking up the machines is about eight weeks. After this the learner alternates between the machine and bench sections throughout his whole course, the last series of bench exercises being jig, fixture and die work. This arrangement develops in the apprentice a wide range of in-

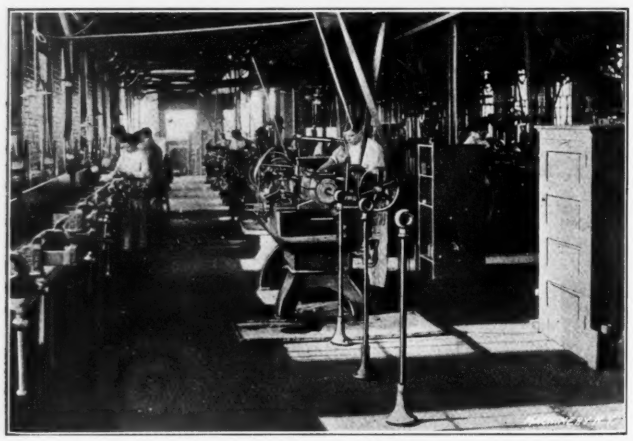


Fig. 4. General View of Machine Shop

sight and a keen sense for detail, which is entirely lacking in the boy who works for months along the same lines, with only slight variation of constructive detail.

Assignment of System

From the foregoing it will occur to the reader that some method of determining what exercises are available on a given job must be in use; also whatever scheme is in service must be rapid in application and easily maintained. When a boy is out of a job, the question before the instructor is not simply that of giving him more work, but rather of giving him work from which can be gained an exercise that will be a reasonable advance on his previous experience. An il-

Fig. 5. Three Advanced Apprentices working on Blanking and Piercing Dies

lustration of an actual job in the shop will best serve to show how this phase of the work is handled:

An order is received by the instructor to make two complete saw guards for the pattern shop. On the day of receipt of this order, after his class has left him, the instructor looks over the prints and finds that the shop work can be done on the lathe, vertical boring mill, drill press, and the assembly work at the bench. Shop orders are made on four blank sheets of paper as follows:

LATHE

Pattern Shop Saw Guard

2

Parting	Straight turning
Centering	Backresting
Facing	Thread cutting
Shouldering	Running fits

Three more such orders are made out, giving boring mill, drill press, and assembling exercises, respectively, under the job heading. These slips are then filed on the order section of the instructor's desk, a view of which is shown in Fig. 1, where may be seen a set of orders for each machine in the shop. The lathe order referred to indicates to the instructor that he is to make two saw guards complete, and he has on the job certain available exercises as listed on the lower part of the order. Now a lathe-hand comes to him for a job, and the instructor immediately notes the nature of the boy's last exercise, picking out the next one for an advance from the list contained in a course outline book.

In leafing over his orders, the instructor does not look at the job, but rather at the exercises listed under each job, and if the lathe-hand needs any one of those named for a particular piece of work, he is assigned to cover that exercise; *e.g.* if the apprentice, in the order of learning his trade should next take up the use of the backrest, the instructor would give him the lathe work on the pattern shop saw guard mentioned above, or any other job which required the use of the backrest, taking his order slips to guide him in the selection. When the job has been assigned, the order for it is destroyed.

Inspection and Its Effect on Boy's Record

After the lathe-hand has completed his work, he puts a tag on it, which gives his name, and the job goes to the inspection room, where it is inspected, a slip being made out by the student inspector for each exercise covered by every boy; the instructor checks the inspection, and determines the mark

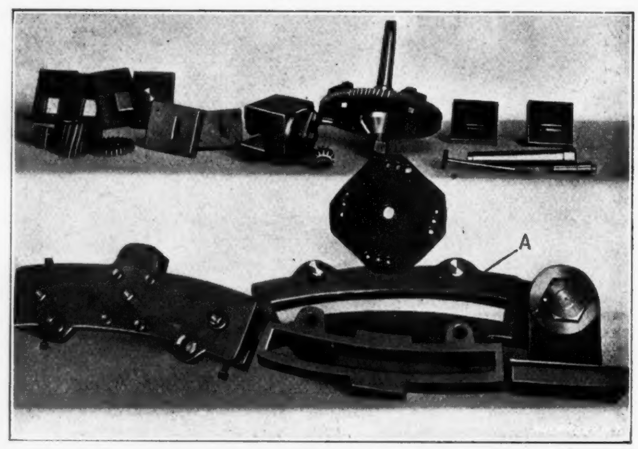


Fig. 6. Dies, Cutters, Jigs and Fixtures, completed or in Process of Completion, representing the Work of the Apprentices

of the apprentice from the quality and time. One of the inspection slips is shown in Fig. 3; the exercises on this job were speed work, and fitting of square threads; a study of this sheet gives an idea of its purpose, though it is nothing other than a slip similar to that used in most up-to-date shops. The mark which this apprentice received for the work was 2½ (seen over the instructor's initials F. S. on the slip), which means to the school authorities that the work was of a common average: 1, means excellent work; 2, good; 3, medium, but not satisfactory; and 4, poor. This outlines the method followed for all machines, and all kinds of exercises, including elementary, speed, and advanced sections.

Shop Talks

While the apprentice is carrying on the shop work, he is given a series of talks, showing the correlation of the principles of his instruction with other jobs of a similar class, but different in form. For example, in the shop talks is listed a series on machine tool types; during the junior year, the various tools of a type differing from those with which the school shop is equipped, are taken up and the method of operating is gone over, giving the apprentice a set of operator's general directions for handling the many different kinds of machine tools. Fig 2 presents a class-room scene when the shop talk was on the operation of the Fellows gear shaper; these talks are from twenty minutes to a half hour in length, the class taking notes as the lecture progresses. Each week these notes are marked for appearance and fullness, these marks being added to the boy's shop record.

Time in Shop and Equipment

The time spent in the shop is 23 hours per week for two years and three months, and 43 hours per week during the remaining nine months of a three-year course. The present shop equipment consists of lathes, planers, slotter, shaper, drill presses, vertical and horizontal boring mill, milling machines (plain and universal), flat turret lathe, grinder, and wet tool grinders; there is also a well-equipped tool-room, supplied with small tools and the necessary accessories. Fig. 4 shows a general view of the machine shop.

About three months of the senior year is spent on jig, fixture and die work; the course does not produce a toolmaker, but the work given in toolmaking is such as should be a part of every first-class machinist's training, and involves the making of blanking dies, as well as jigs and fixtures. The ultimate aim in this connection is to devote one year to toolmaking, so the young machinist may not only meet with success in the shop but in the tool-room as well. Fig. 5 shows three of the 1911 apprentices working on blanking and piercing dies while Fig. 6 presents some dies, cutters, jigs and fixtures recently finished, and in process of completion, giving an idea of the class of work being done at the present time, in toolmaking lines. Fig. 7 shows the milling jig seen at *A*, Fig. 6, set up on the machine and in operation; the piece standing up at the end, marked *B* in Fig. 7, is the work milled. The contrivance is a bridge milling fixture for finishing a curved slot, and an outside surface true to such a slot.

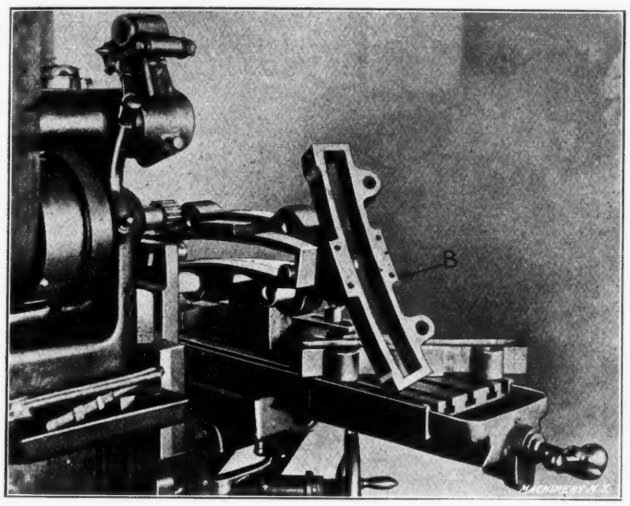


Fig. 7. Drilling Jig shown in Fig 6, set up and in Operation

Fig. 8 shows the apprentice on the horizontal boring mill, when he was setting up to bore the bridge piece of the fixture just mentioned. An examination of the halftone shows him to be using the bar and height gage method of locating for accurate boring; for the purpose of this article, no further details of the process are necessary.

Speed Exercise and Its Meaning

Fig. 9 is presented for the purpose of giving an idea of the way in which the speed exercises are handled by the teacher in the class. The apprentice, for the development of the faculty of covering repeated operations rapidly and with ease, requires different instruction from that necessary for mastering the first principles of a process; to this end, he must do quite a number of pieces of the same kind, while the instructor centers his effort, not on the teaching of trade elements, since these should have been mastered previously, but on methods of arranging the tools and work in such order as to eliminate unnecessary motions, having tools always in readiness, and on the development of the ability to make every movement count towards a desired end. The aim in all the speed exercises is to teach the student to concentrate his attention specifically on a fixed set of movements, and develop the ability to select the minimum number of steps necessary to the carrying out of any particular job. Fig. 9 shows an apprentice covering a speed exercise on the flat turret lathe.

The Spirit of the Work

A school shop is in no way different from any other machine shop, nor is there any reason why it should be; the output, however, instead of being reckoned in cash, is studied from the standpoint of better citizenship, and a higher earning power of the individual. Every effort is made to teach the honest, faithful boy a trade; he is not dismissed simply because he is dull, or because of the fact that natural tendencies are unfavorable to him; the one fixed requirement at a trade school is an honest desire to become a capable, well trained mechanic, and a willingness on the part of the boy to be guided by those of broader experience than himself.

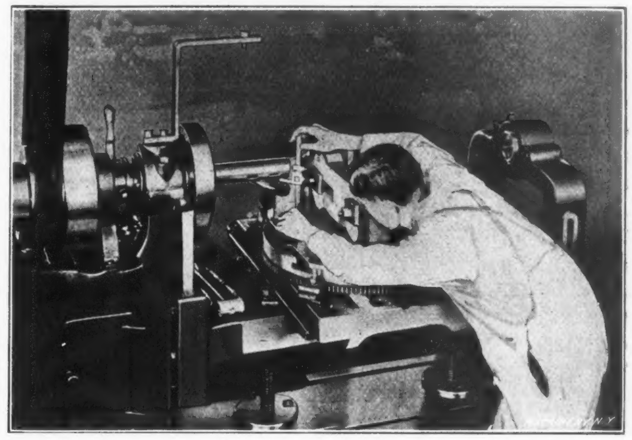


Fig. 8. Apprentice setting up Jig for Boring on the Horizontal Boring Mill

Training for Jobbing

Since it is by no means a certainty that our young machinist will go to work in a shop running under the factory system, he must be trained as well for the jobbing shop, where he takes a job directly from the beginning to its completion, on all the machines, and through all the fitting, assembling, etc. This work is done at night, during the latter part of the third year, when there is none but the senior class in the shop. All the tools are then available for their use, giving a larger number of machines per boy. The apprentice at night works on a different job, has another time card, and the teacher gives his attention to developing the ability of the boy in changing from one tool to another without loss of time, the selection of the proper machine or method for doing the job most rapidly, and ways of keeping the work always on the move. Before taking this practice the boy should be trained as an operator of every tool in the shop, after which comes quite logically, the correlation of a number of machines on a given job.

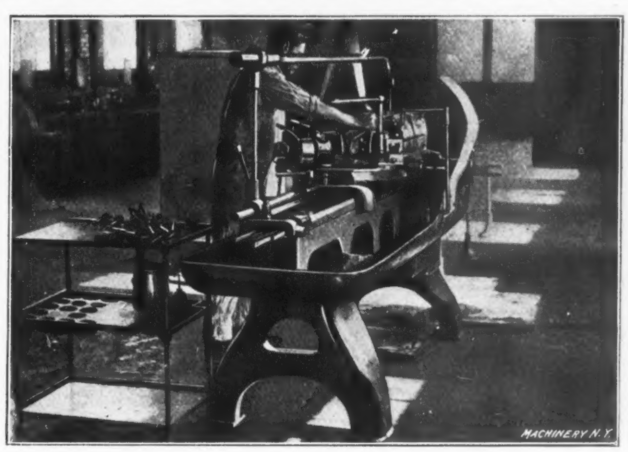


Fig. 9. Apprentice covering a Speed Exercise on the Flat Turret Lathe

Academic Work

Every apprentice receives instruction in academic work; this will not be gone over in detail, but the general outline following gives a very good idea of this requirement in trade schools. In planning academic work for such schools, there must be kept clearly in mind the fact that the organization is to be neither a secondary school, nor a college, but rather

a place where young men are fitted for life's work. To this end, the course should be of such a scope as will enable the young mechanic to readily read a drawing from which he may have to work, use mathematics in the practice of his trade, obtain a general knowledge of the development of his native land, and to use the English language with a reasonable degree of correctness.

Cost Considerations

One of the criticisms of high-grade trade school training which is often made is the cost, the statement being made that the man who is trained in a trade, must be developed at a relatively small outlay, because no community which must support its school on a tax basis is willing to make large expenditures, as the ultimate earning capacity of the mechanic does not warrant such a policy. This may or may not be good social economy, but in any event, such statements are not made by men who really know how to manage a trade school on the basis of economy and efficiency. It is a fact that where credit is given for the work done as exercises, no school in existence can show the low cost operation per pupil of the trade school, while at the same time it sends into the world a type of young American which is esteemed both by the manufacturer and society at large. These results depend, however, on the school having absolute control of the work used as exercises, a free hand to teach the trade in a first-class manner, a capable staff of officers and teachers, and a willingness on the part of all concerned to shape the course of affairs without hobbies or pet theories, to the end that capable and efficient mechanics be produced.

The number of persons who say a trade cannot be taught in a school is becoming fewer each year; while it is true that many trade schools do not make capable journeymen, it is equally true that many shops take apprentices, and after the stipulated period of service the young man is not regarded as a workman by any other firm than the one with which he served his time. Again there is no clearly defined conception of just what a machinist is, but the school may feel safe in stating that it turns out mechanics when the employer will take a boy directly from the school shop, and after an unprejudiced trial, give him, on the basis of his work, the same rate of pay that he gives any young machinist whom he may hire. If, as has been the case at Williamson, an employer takes a boy after a three-year apprenticeship, and gives him the same rate of pay as he commonly gives a boy who has served a four-year apprenticeship in the shop, then the school must be doing better than the shop for the boy, since it has taken one year less of his time to bring him to a given earning capacity, and at the same time it has offered him with his trade a good general education, which has not been the good fortune of the shop boy, unless he has been so situated as to employ a private teacher. If the school boy cannot meet the requirements of the employer, it is not of course wise for a school to claim that it turns out mechanics, since the ability to "make good" must, in justice to all, be the one criterion by which the young mechanic shall be judged.

* * *

RADIAL GRINDING FIXTURE

The accompanying illustration Fig. 1 shows the general construction of a convenient radial grinding fixture used in the shops of the L. S. Starrett Co., Athol, Mass. Fig. 2 is a sectional view showing the design of the grinding head. The grinding fixture is attached to a No. 3 Ames bench lathe. It consists of five main parts—a base *A*, a pivot *B*, a swivel *C*, a slide *D*, and a grinding head *E*. It will be seen that the construction of the pivot stud *B* is along the same lines as commonly used on watchmakers' lathes, the angles on the stud being selected so as to approximate the form of the Schiele curve, which is the theoretical form for the most efficient type of thrust bearing. The angle on the upper part of stud *B* is 3 degrees on each side, and the angle at the bottom 45 degrees, as indicated. The swivel joint is carefully enclosed to prevent any grinding dust from entering its bearings. The screw-operating slide *D*, for obtaining different radii and also for adjustment for different sizes of grinding wheels, has 10 threads per inch and is provided with a micrometer collar for obtaining fine adjustments. The grinding head shown in detail in Fig. 2 is provided with two thrust bearings of the same form as that used for the swivel stud. The bearings are entirely enclosed by brass dust caps. The design is of an approved and thoroughly tested form

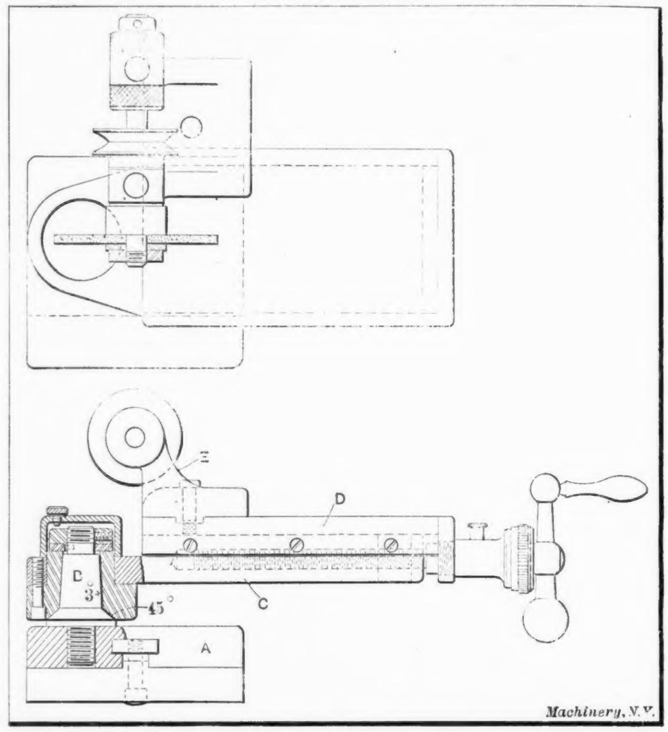


Fig. 1. Radial Grinding Fixture used in the Shops of the L. S. Starrett Co.

for high-speed spindles. The steel bushings in which the spindle runs are hardened and ground all over, and are a tight fit in the cast-iron head. The spindle is also hardened. The action of the device is clearly indicated in Fig. 1. The swivel *C* with slide *D* and grinding head *E* can swing completely around stud *B*, so as to grind any part of a circular

Fig. 2. Section through Head of Radial Grinding Fixture

arc. The radius of the arc is determined by the distance from the vertical center line through stud *B* to the cutting face of the grinding wheel.

* * *

LARGEST CRANE IN EXISTENCE

The largest crane in existence has recently been erected at Govan on the river Clyde, Scotland, for the Fairfield shipyards. The jib head of the crane is of the hammer-head type, built on the cantilever principle, and stands 160 feet above high-water level. The jib, with a total length of 270 feet, extends 169½ feet outward from the center and can be used at any point within a circle of 336 feet diameter. The crane, on slow gear, can elevate 200 tons at an arm of 75 feet, and a load of 100 tons at an arm of 133 feet.

THE UNIVERSAL JOINT*

By ALTON L. SMITH†

If two revolving shafts are placed so their center lines intersect, but are not in the same straight line, they may be connected by a universal joint which will transmit the motion from one to the other. This joint is often called a "Cardan joint" or a "Hooke's coupling" after the Italian who first described it and the Englishman who first applied it. Its form varies according to the particular use to which it is put, but all forms reduce in principle to the one shown diagrammatically in Fig. 1.

The shafts *AB* and *HJ* are held in place by the rigidly connected bearings *M* and *N* which also prevent end motion. Where these shafts extended meet at *E*, there is a cross-shaped piece with equal arms *CD* and *FG* rigidly connected and intersecting in their middle points at right angles. A fork, *CBD*,

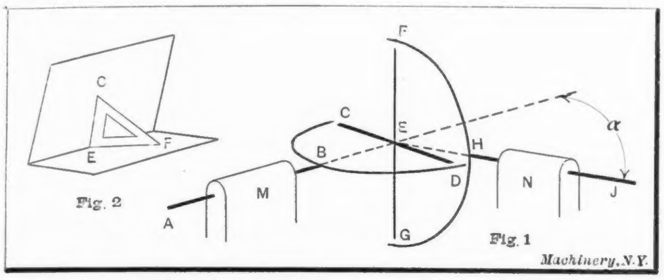


Fig. 1. Simple Universal Joint. Fig. 2. Illustrative of the Line of Intersection of the Two Planes

is attached rigidly to the shaft *AB* and connected to the cross-arm *CD* by rotary bearings at *C* and *D* so that *CD* is perpendicular to *ABE*. In the same way, a fork *FHG*, is attached to *HJ* rigidly and by rotary bearings to *FG* so that *FG* is perpendicular to *JHE*. At first sight, it does not appear possible that such a connection will transmit motion from one shaft to the other, but the reader can prove this easily to his own satisfaction in the following manner: As *CD* is perpendicular to *ABE*, when *AB* revolves, *CD* moves always in a plane passing through *E* and perpendicular to *ABE*. In the same way, *FG* moves always in a plane passing through *E* and perpendicular to *JHE*. These two planes intersect in a straight line whose position does not change, and *E* always remains at the

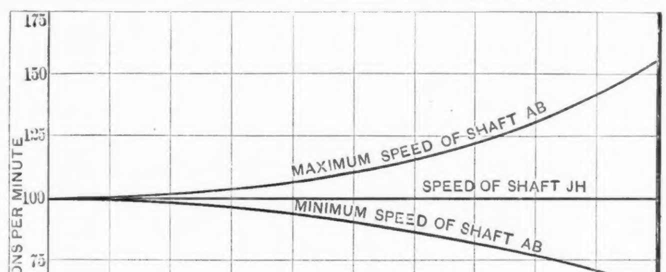


Fig. 3. Graphical Representation of the Results shown in Table I

same point on this line. As shown in Fig. 2, there are two intersecting planes with a fixed point *E* in their line of intersection. A right angle *CEF* must move so that one side *EC* always lies in one plane, the other side *EF* lies in the other plane, and the intersection of the two sides is always at *E*. If the reader will open a book at any angle to represent the two planes and take a draftsman's triangle for the angle *CEF*, it will be found that it is possible to move the triangle according to the specified conditions.

A universal joint is sometimes made so that the four bearings *C*, *D*, *F* and *G* are not in the same plane. When this construction is used, only one of the two connected shafts can be held in place rigidly and permit rotary motion. Such a construction has only a very limited use.

Geometrically, the angle α in Fig. 1 could be anything between 0 and 180 degrees, but because of interference of forks which must have material dimensions, the angle α must be something less than 90 degrees. At just 90 degrees, the mechanism would fail, because, as can be seen from Fig. 1, rotation of *HJ* would simply turn *CD* on its fork bearings without any tendency to rotate *AB*. When α is nearly 90 degrees, the mechanism cramps because the force tending to cause rotation is dissipated in friction. Practically, the angle α should not greatly exceed 45 degrees when loads are transmitted at very slow speeds, as for instance in opening and closing small valves by hand. When the load is very small the angle may be as high as 60 degrees, and some special joints admit of as high an angle as 70 degrees without interference of parts. At higher speeds, the angle must be less if durability is to be insured, for the inertia effects produce high stresses in the bearings and forks, thus necessitating larger dimensions for them which, in turn, produces interference unless the shaft angle is reduced.

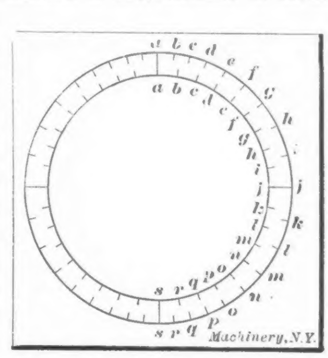


Fig. 4. Graphical Representation of the Results shown in Table II.

TABLE I. COMPARATIVE SPEEDS OF DRIVING AND DRIVEN SHAFTS

Speeds of shaft AB when shaft JH runs at 100 R. P. M. for Various Shaft Angles

Shaft Angle, Degrees	Max. Speed 100 sec α	Min. Speed 100 cos α	Variation R. P. M.	Shaft Angle, Degrees	Max. Speed 100 sec α	Min. Speed 100 cos α	Variation R. P. M.
5	100.38	99.62	0.76	30	115.47	86.60	28.87
10	101.54	98.48	3.06	35	122.08	81.92	40.16
15	103 53	96.59	6.94	40	130.54	76.60	53 94
20	106.42	93.97	12.45	45	141.42	70 71	70.71
25	110.34	90.63	19.71	50	155.57	64.28	91.29

The use of this coupling is often prohibited by the variation of velocity ratio of the connected shafts during a single rotation. If shaft *JH* runs at a constant speed of 100 revolutions per minute, shaft *AB* will make 100 revolutions also, but it is found that during one part of a revolution *AB* will run faster and during another part slower than *JH*. In Fig. 1, suppose shaft *JH* to be the driver and let its initial position be as shown, with *FG* perpendicular to the plane *AEJ*. Let θ be the amount of angular turning of *JH* from its initial position. Then it can be proved that

$$\frac{\text{Ang. vel. of shaft } AB}{\text{Ang. vel. of shaft } JH} = \frac{\cos \alpha}{1 - \sin^2 \alpha \sin^2 \theta}$$

This equation gives the relation of the two shaft velocities during one revolution. It can also be proved that with shaft *JH* running at constant speed, shaft *AB* has its minimum speed when fork *FHG* occupies the position shown in Fig. 1, and its maximum speed is when the fork has turned through 90 degrees from this position. For the first position, the angular velocity of shaft *AB* is equal to the angular velocity of shaft *JH* multiplied by cos α. For the second position, the angular velocity of shaft *AB* is equal to the angular velocity of shaft *JH* multiplied by sec α. Table I gives maximum and minimum speeds for shaft *AB* for various values of the shaft angle α, assuming that shaft *JH* drives at a constant speed of 100 revolutions per minute. Fig. 3 shows the same thing graphically.

While a slight fluctuation in the velocity ratio might not be objectionable, there will often be objection to the variation in the relative angular positions of the two shafts which accompanies it. Table II shows the angular advance and lag of shaft *AB* for successive angular positions of shaft *JH* when

* For further information on the subject see the editorial "Bad Practice in the Use of Universal Joints," September, 1910, and the article "Universal or Flexible Joint Couplings," April, 1902.

† Professor of Machine Design, Worcester Polytechnic Institute, Worcester, Mass.

the shaft angle is 45 degrees. The zero position of shaft *JH* is that shown in Fig. 1. If ϕ is the angular motion of *AB* corresponding to θ, the angular motion of *JH*, then $\tan \phi = \cos \alpha \tan \theta$. Fig. 4 represents the values of Table II graphically; divisions on the inner circle show the angular positions of shaft *JH*, while those on the outer circle show the corresponding positions of shaft *AB*.

The variation in velocity ratio and in the relative angular positions of the two shafts may be avoided if two joints prop-

TABLE II. RELATIVE ANGULAR POSITIONS OF SHAFTS

Relative Angular Positions in Degrees of shafts JH and AB during one Revolution for Shaft Angle of 45 Degrees

AB Lags				AB Leads			
	JH	AB	Diff		JH	AB	Diff.
a	0	0	0	j	90	90	0
b	10	7.1	2 9	k	100	104	4.00
c	20	14.43	5.57	l	110	117.24	7.24
d	30	22.21	7.79	m	120	129.24	9.24
e	40	30.68	9.32	n	130	139.88	9.88
f	50	40.12	9.88	o	140	149.32	9.32
g	60	50.76	9.24	p	150	157.79	7.79
h	70	62.76	7.24	q	160	165.57	5.57
i	80	76.0	4.00	r	170	172.9	2.9
j	90	90.0	0	s	180	180	0

erly arranged in series are used. Fig. 5 shows two shafts, *A* and *C*, non-intersecting and non-parallel, connected by a double Hooke's coupling in which *B* is the intermediate shaft. The ends of the connecting cross arms, as has been previously shown, follow circular paths. In Fig. 6, are shown the projections of the paths of *c*, *d*, *a* and *b* on a plane perpendicular to shaft *B*. As the plane of the circle described by *a* and *b* is oblique to shaft *B*, the projection of the path is an ellipse, while the path described by *c* and *d* being perpendicular to shaft *B* projects as a circle. From the construction of the joint, the cross arm *cd* is always perpendicular to shaft *B*, and therefore always parallel to the plane of projection shown in Fig. 6. The arm *ab* is actually perpendicular to the arm *cd*. From these two facts, it follows that in the projection, Fig. 6, *ab* and *cd* will always be at right angles for successive positions during the rotation of the connected shafts. In the same way in Fig. 7, there is a similar projection for the paths followed by *ef* and *gh*. If shafts *A* and *C* make the same angle with the shaft *B*, the projections of paths of *ab* and *gh* will be ellipses of the same shape. Without disturbing any other part of the arrangement, let the fork at the left end of shaft *B* be loosened and turned on the shaft, carrying *a*, *b*, *c*, *d* and shaft *A* with it, until *cd* projects at *c'd'*, Fig. 6. Now fasten the fork rigidly to shaft *B* again and let shaft *B* be turned through a small angle as indicated by the arrows. Points *f* and *d'* being on the same rigid rotating piece at the same distance from the axis, will each move through the same distances on their respective circular paths, and *ff'* will equal *d'd''*. Also, because the cross arms are always at right angles in the projections Figs. 6 and 7, and because the two ellipses are alike, then *b'* and *g* will move the same distances on corresponding parts of their elliptical projections and $gg' = b'b''$. As these ellipses are projections of equal circles, points *b* and *g* will move actually through equal space distances. Therefore shafts *A* and *C* have been revolved through equal angular displacements. From this it follows that if shaft *A* turns at constant speed, shaft *C* will turn at the same constant speed.

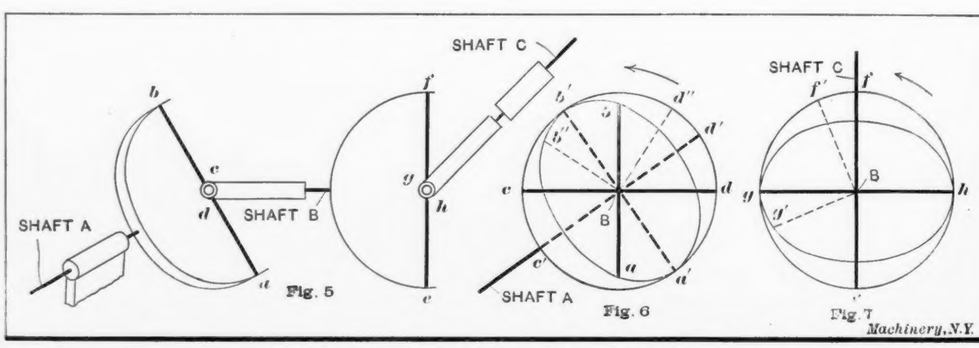


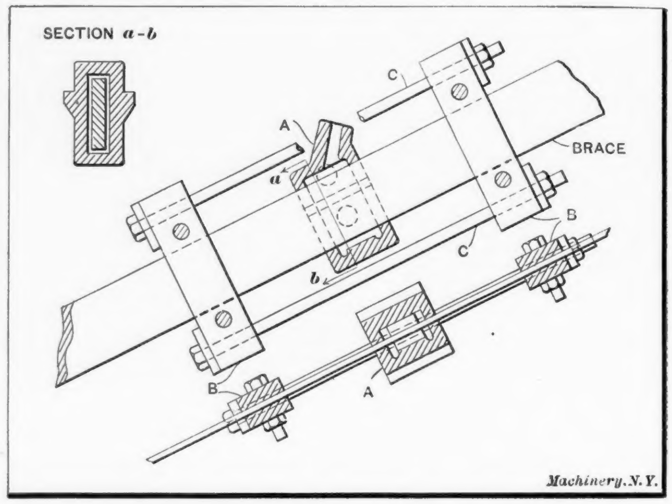
Fig. 5. Two Non-intersecting and Non-parallel Shafts connected by Double Universal Joints. Fig. 6. Projection of ab and cd on a Plane perpendicular to Shaft B. Fig. 7. Projection of Arms ef and gh on a Plane perpendicular to Shaft B

An inspection of Figs. 5, 6 and 7 will show that two conditions are necessary to produce this constant speed ratio between shafts *A* and *C*. First, shafts *A* and *C* must make the same angle with shaft *B*; second, the forks on shaft *B* must be placed relatively so that when the plane of the one at the left end contains the center lines of shafts *A* and *B*, the plane of the right-hand fork must contain the center lines of shafts *B* and *C*. It will be seen from this that a great variety of positions may be selected for shafts *A* and *C*. One of the commonest arrangements is that when the shafts *A* and *C* are parallel; in this case, the forks on shaft *B* will be placed in the same plane. This arrangement has been utilized for the carriage feed on milling machines.

* * *

TIGHTENING STAYS IN STEEL STRUCTURES

An efficient means of tightening up slack members in bridges and similar structures has been developed by Mr. Albert Haskenkamp, Essen, Germany; the process is de-



Patented Apparatus for Applying Thermit to Shortening Bridge Stays

scribed in *Reactions*. Previous to its introduction, a brace that needed shortening required to be removed and upset in the forge.

The new method, which employs thermit, consists in encasing the brace at some convenient place with a two-piece shell, as at *A* in the illustration, luting the joints with clay. Straps *B* are clamped around the brace, above and below the shell, and are connected to each other by bolts *C*, which draw the two clamps together. Thermit is ignited in a flat-bottomed crucible, and at the end of the reaction is poured into the mold, the slag being allowed to enter first so as to coat the bridge member with a protective layer, in order that none of the metal will come in contact and adhere. This liquid mass being poured at a temperature of from 3000 to 4000 degrees F., brings the steel to a red heat, when the clamps can be tightened, upsetting the section at the heated part. If the shortening is but slight, no tightening is required, for the heated member, tending to expand, is restrained from so doing by the clamps and automatically upsets.

In the case of double braces where it is desired to upset only one of them, the other member may be surrounded with refractory material as insulation, confining the heat to that part of the brace which requires shortening.

TESTING A CYLINDRICAL GRINDER

PRACTICE OF THE LANDIS TOOL CO.

By FRANKLIN D. JONES*

The accurate nature of the work for which a grinder is ordinarily employed, combined with other requirements that are essential to a machine of this type, make it necessary to finish practically every part used in the construction with considerable precision; but notwithstanding the precaution taken in the finishing of each unit or member that goes to make up the completed machine, slight errors are unavoidable, some of which are due to inherent imperfections in the manufacturing tools used, while others result from differences in the skill and judgment of the workmen. These errors would be quite insignificant if considered independently, but when the machine is assembled, even very slight inaccuracies sometimes become serious because they accumulate or add themselves together, thus causing a disalignment of one or more important parts—all of which is familiar to every mechanic who has had experience with precision work. The methods employed in the final inspection of the cylindrical grinders built by the Landis Tool Co., Waynesboro, Pa., for detecting these accumulative errors and other minor defects will be referred to in connection with the accompanying illustrations which show the testing tools used and their application.

The work of inspecting a grinder does not, of course, begin when it is assembled, but some of the more important tests cannot be made until the machine is erected and ready for operation, and while those which precede are essential, most of them are of an obvious nature and need not be referred to. The attention of the inspectors is focused principally on the relation between the wheel carriage and the platen with its work-centers. The wheel carriage must travel in a straight line and parallel with the top surface of the platen; the work-centers must be in alignment with each other and parallel with the platen; and the top surface and front edge of the platen must be true plane surfaces within close limits, to permit adjusting the headstock and tailstock to different positions without affecting their alignment. Of course it is neither practicable nor necessary to align the various members to absolute perfection as shown by the indicators, but the limits of variation are so small as to be scarcely appreciable.

* Associate Editor of MACHINERY.

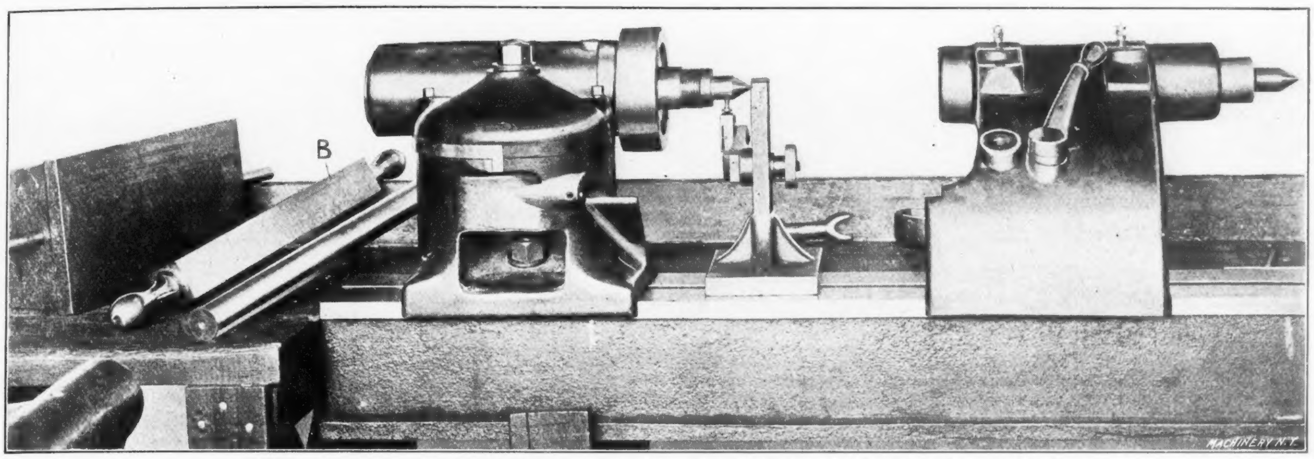


Fig. 1. Preliminary Test to determine Parallelism of Headstock and Tailstock Spindles with Base

The first inspection to which the assembled headstock and footstock are subjected, is illustrated in Fig. 1. This inspection takes place in the fitting department before the parts are assembled on the finished machine, and the test shows the position of the spindle with relation to its base. The test indicator used is adjustably mounted on a large base, and its indicating point is first brought into contact with the underside of the spindle center as shown. The spindle is then reversed in its bearings and a similar test is made on the opposite side. The variation shown by the indicator is noted, and if it is greater than the allowable limit, the base is scraped to make it parallel with the spindle. After this operation, the parallelism of the spindle with relation to a front locating projection *A* is determined as shown in Fig. 2. For this test the gage is attached to a special base which also has a projection or lip as shown. By bringing the indicator into contact with the front side of the spindle center and reversing the spindle as before to test on both sides, any disalignment with the locating projection is shown. The necessary adjustments in this direction are made by scraping the inner surface of part *A*, and the latter is kept square with the base while being scraped, by testing bar *B*, Fig. 1. The spindles of the headstock and footstock are both tested in this manner to determine their alignment with each other, as well as with the base. These tests are made on a special surface-plate instead of on the machine platen, as it is more convenient and prevents the finished platen from being marred. The taper hole in the headstock spindle for the work center, is also tested in the fitting department to determine whether or not it is concentric with the exterior of the spindle, by applying the gage to the work-center, as in Fig. 1, and turning the spindle by hand.

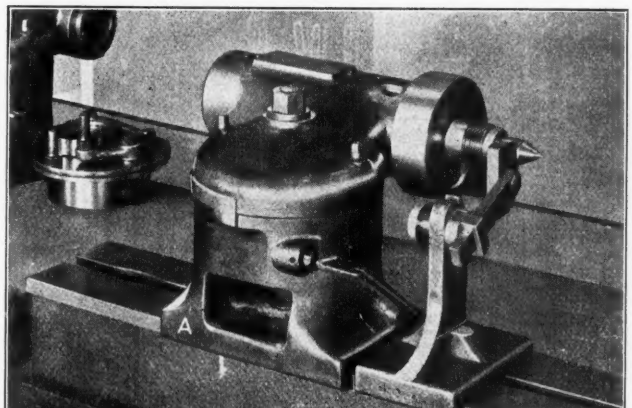


Fig. 2. Testing Parallelism of Spindle with Locating Projection in Front

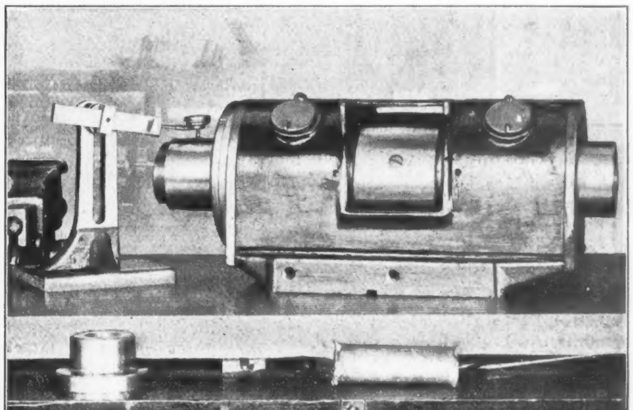


Fig. 3. Testing Wheel Spindle for Parallelism with Base

The wheel spindle of a grinder is, of course, a vital part of the machine, and owing to its high rotative speed and the necessity of eliminating all play and vibration, the bearings must be fitted very carefully. These bearings are tested on

the heavy cast-iron table or bench shown in Fig. 4, by attaching the base and assembled spindle to this bench and rotating the spindle by a belt from an overhead drum, as shown. As the test speed is from two to three hundred revolutions per minute faster than the regular working speed, any imperfections in the bearings are soon detected by the excessive heat generated. After each spindle is run for a time, it is removed and any high spots which show on the phosphor-bronze bearings are carefully scraped; in this way a good bearing is obtained under conditions more severe than are encountered in actual practice. The spindle is then run for several hours to make sure that it will operate indefinitely without becoming heated above a normal temperature. The wheel spindle is also given a preliminary test in the fitting department to see if it is parallel with finished surface of the base. Collars of the same diameter are placed on each end of the spindle and the test is made as shown in Fig. 3.

When the grinder is assembled, the alignment of the various members with relation to one another, is determined by a series of final tests which locate any accumulative errors and insure an accurately constructed machine. Prior to these tests, the wheel carriage and its reciprocating mechanism is operated for two or three days by a special motor in the testing department to give the machine a smooth action and the wheel carriage a more perfect bearing on the ways of the bed.

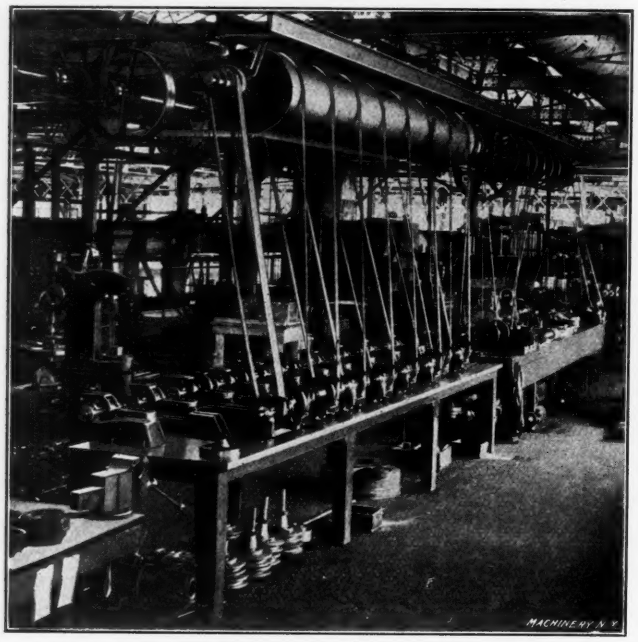


Fig. 4. "Running in" Wheel Spindles prior to Assembling

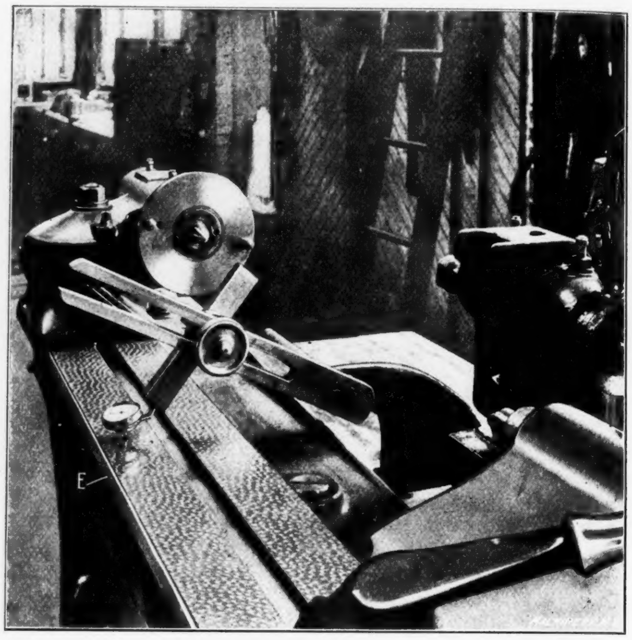


Fig. 5. Testing Top of Platen with Reference to Wheel Carriage Travel

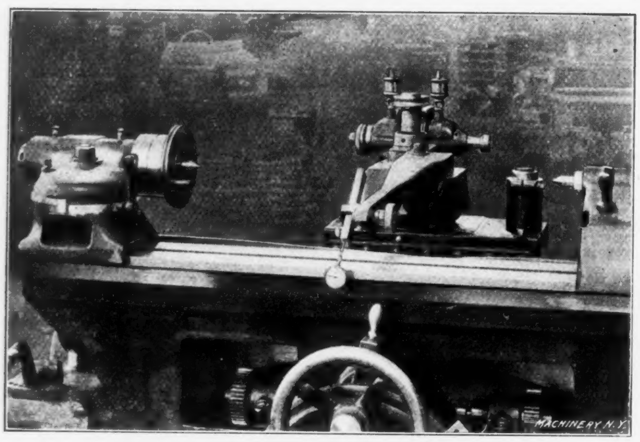


Fig. 6. Aligning Front Edge of Platen

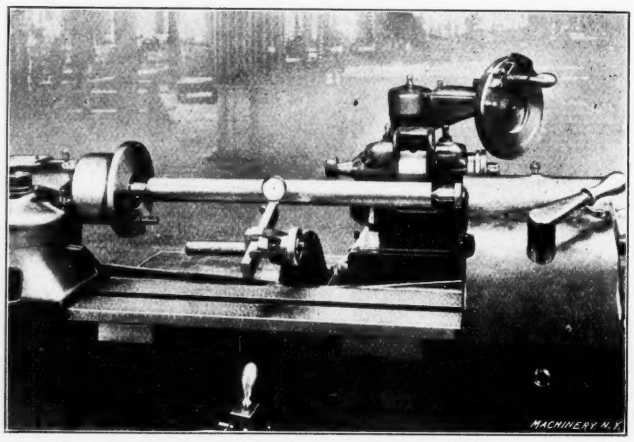


Fig. 7. Testing Alignment of Work-centers with Carriage Travel

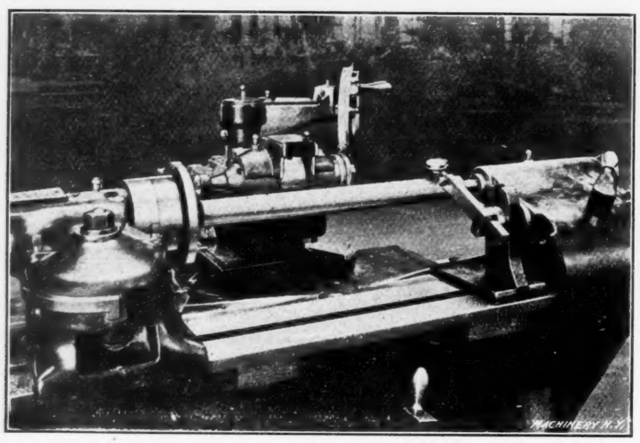


Fig. 8. Testing Parallelism of Bar between Centers with Platen

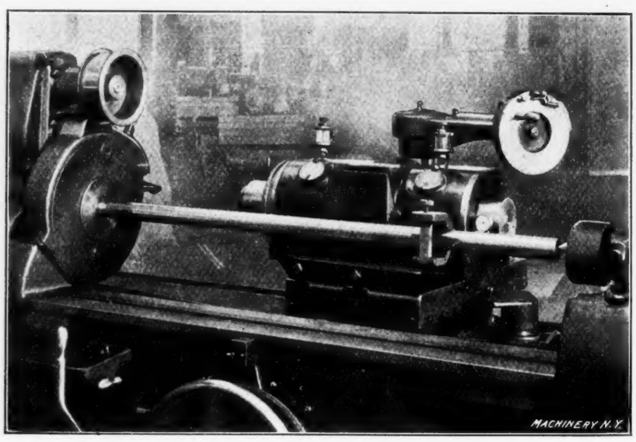


Fig. 9. Testing Wheel Spindle Alignment on Plain Machine

The top surface of the platen is first tested with relation to the travel of the wheel carriage as shown in Fig. 5. A bracket is bolted to the wheel carriage to which is attached an adjustable arm and a dial indicator. When the indicator is traversed along the platen by moving the wheel carriage, the

dial shows whether or not the platen surface is straight and parallel with the carriage travel. The front edge *E* against which the headstock and footstock are located, is then tested with the indicator adjusted to the position shown in Fig. 6, the indicator being traversed by the wheel carriage as before. The platen is swiveled to bring this front edge parallel with the carriage travel, after which a steel pointer or knife-edge is screwed to the bed in a position coinciding with the zero position of the graduations for indicating tapers. This test also shows whether the front or locating edge is perfectly straight.

The headstock and footstock are next clamped in position and a long test-bar is placed between the centers as shown in Fig. 7. The wheel carriage is then traversed with the gage in contact with the side of this bar, which shows if the work centers are in alignment laterally with the wheel travel. As this test is made with the swiveling platen in its central or zero position, the alignment must be practically perfect, for otherwise the machine will grind taper instead of straight or cylindrical as indicated by the scale. The test shown in Fig. 8 is next made to determine the alignment of the centers with reference to the top of the platen. The gage is applied to the top of the test-bar and it is mounted on a broad base which is moved along the platen. The base having a projection that bears against the front edge of the platen, is then substituted to test the alignment of the bar with this edge. Inasmuch as the headstock and footstock spindles were tested previously in the fitting department, as explained, these final tests prove the accuracy of alignment, and working conditions are practically duplicated by having a test-bar mounted between the centers. Of course, the errors shown by these tests would in any case be very small.

The next operation on a universal machine is not strictly a test, but rather a method of locating a datum line at *L* (Fig. 10) on the wheel carriage for setting the graduated swiveling wheel-slide to any angular position with reference to the work-centers. The swiveling slide is graduated by a special machine before being assembled. To locate the datum line, the slide is swiveled around to the position shown, and it is set parallel with a test-bar between the centers by traversing it with an attached indicator in contact with the side of the bar. When this indicator shows that the movement of the slide is parallel to the test-bar, a line is made on the carriage exactly opposite the 90-degree division. The coincidence of this datum line with any of the other angular graduations, when located as described, shows the exact angle that the travel of the wheel-slide makes with the work-centers when the latter are set for straight grinding. Fig. 9 illustrates the method of testing the wheel spindle of a plain grinder for parallelism with the travel of the wheel carriage. Closely fitting collars having the same outside diameter are placed on each end of the wheel spindle as shown, and a V-shaped gage with an indicator attached to its end is brought into contact with first one and then the other of these collars by moving the wheel carriage along its ways. The position of the wheel spindle in a vertical plane is also ascertained by bringing a gage that rests on the platen into contact with the upper side of the collars, as illustrated in Fig. 11.

The tests which have been described in the foregoing have to do exclusively with accuracy of alignment, which is, of course, absolutely essential to a machine of this type. These tests, however, constitute only a small part of the inspector's work, as all details, including the attachments, etc., are examined for defects either as to size, adjustment, or operation. To insure that every part is properly examined, "inspection sheets" are used that contain a list of all the important requirements which experience has shown to be essential to a well-built grinder. As each test listed for the details of various members is made by the inspector, it is checked off the inspection sheet for that particular machine, provided the part comes up to the required standard. In this way a record is kept which eliminates any chance of incomplete inspection, and the inspector's check-mark, which is practically an O. K. signature, tends towards more careful and conscientious work than would be obtained otherwise. This inspection sheet, which is eventually filed, also contains the drawing numbers of the various assembled and detail parts as well as other information of a miscellaneous nature which is often needed for future reference. The grinder, after the work of inspection is complete, is run for a few hours on all the various speeds and rates of traverse as a final test to insure perfect operation.

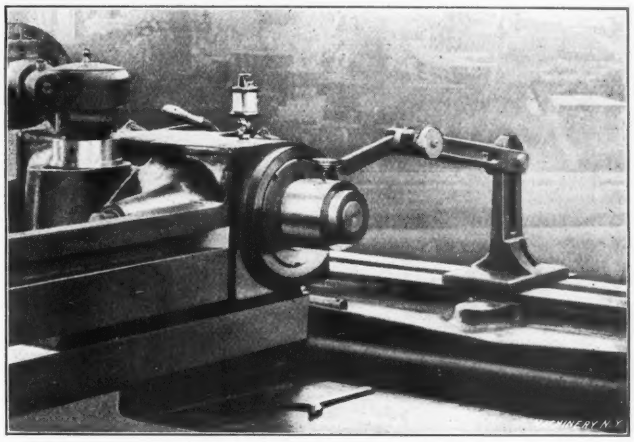


Fig. 11. Testing Position of Wheel Spindle with Reference to Platen

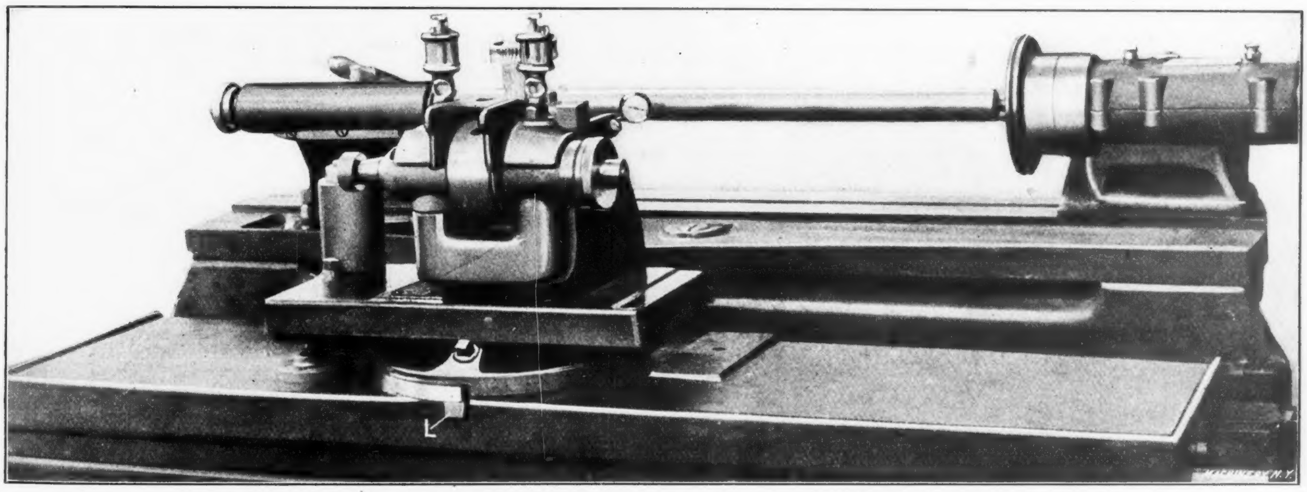


Fig. 10. Setting Wheel-slide Parallel to Work-centers for Locating Datum Line of Angular Graduations

* * *

Some interesting conclusions reached by Prof. Kammerer of Charlottenburg, Germany, after conducting over one thousand tests on belt drive, are reported in *The Wood Worker*. The more important of these are as follows: The effective pull on a belt is not reduced by centrifugal force to the extent commonly believed; the coefficient of friction increases with the speed and reaches values far in excess of those usually assumed; the maximum efficiency of transmission is not limited by the speed; and at any speed the sum of initial tension and centrifugal force is constant. Other conclusions derived conform with generally accepted data.

THE DESIGN OF DIE-CASTING MACHINES —ALLOYS FOR PRESSURE CASTINGS*

By E. F. LAKE†

Die-castings have become fairly well known in the past few years, but the machines, metals and methods employed in their manufacture are as yet very little known. This is due no doubt to the fact that the apparatus and methods employed have been zealously guarded as secrets by those engaged in their manufacture. It may be surprising to many to learn that the commercially successful manufacture of castings from alloys in metal die-molds has not been accomplished through any recent invention, nor has it been the result of any individual's efforts. Like most other industries, this has been a gradual growth, through a period covering more than sixty years. The machines have been slowly perfected, and the alloys for the castings have been continually improved. Thus it is now possible to make dense, sound die-castings from alloys, nearly as strong as brass, and the writer has a process by which a very strong bronze can be cast in die-molds.

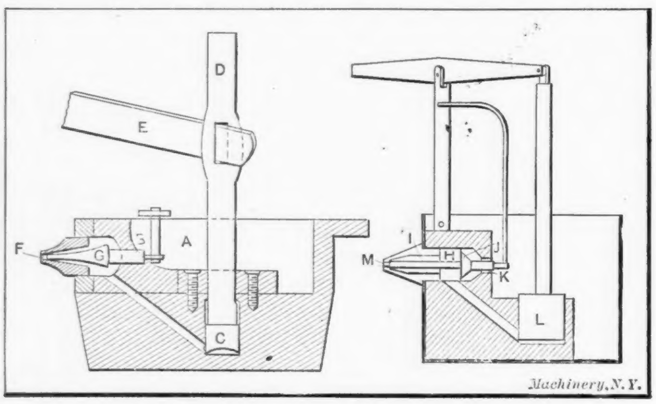


Fig. 1. Type-casting Machine built in 1849. Fig. 2. Improvement in the Type-casting Machine, made in 1856

Historical Development of Die-casting Machines

The first machines or methods along this line were used to manufacture bullets and type; the one being used to murder man and the other to educate him. Most of us are familiar with the iron hand-molds, in which we used to make bullets as boys. Thus it will be hardly necessary to illustrate these. Many inventions were made and patents taken out in the years preceding and following the American rebellion, the Mexican war and the American revolution.

Of the type-casting machines, the first one that we can obtain an illustration of was patented on March 27, 1849, by J. J. Sturgiss. A sectional view of this machine is shown in Fig. 1. This illustrates the basic principle on which most of the die-casting machines in use today are built. In this machine the molten metal flows from the pot *A*, which is surrounded with heat, through the opening *B* into the cylinder *C*. Plunger *D* is then forced down by the lever *E*, which is operated by a cam and connecting-rods, and forces the metal out of nipple *F* into the type-mold. Piston valve *G* is then forced forward to squeeze the metal into the mold and also cut off the liquid stream, so it will flow back into the pot.

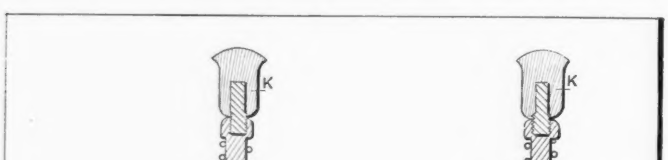


Fig. 3. Small Hand-operated Machine built in 1872

This was followed in 1852 by another patent by W. P. Barr covering other points on a machine which worked in practically the same manner as that shown in Fig. 1. As shown in Fig. 2, E. Peluze patented an apparatus on similar lines in 1856. His improvement over the two former machines was in the piston valve *H*. In this, valve *I* was moved back until beveled surface *J* closed opening *K*, through which the molten metal flowed. Plunger *L* was then forced down, and this made the metal flow through nipple *M* into the type-mold. After this, piston valve *I* was forced forward, the same as in Fig. 1, and for the same reasons.

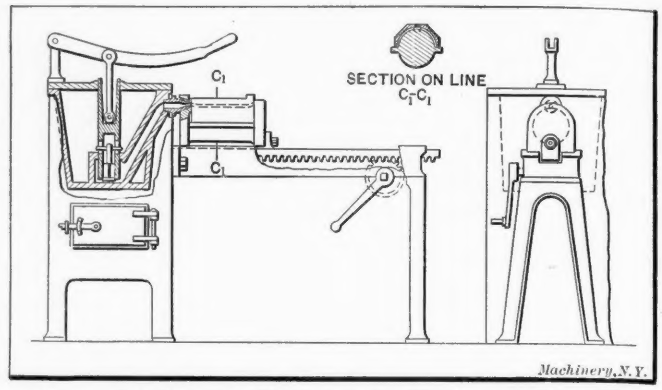


Fig. 4. First Die-casting Machine built for Miscellaneous Work (1877) set up for Casting Bearings

In 1872 a small hand machine was patented, as shown in Fig. 3. This was filled with molten metal from a melting pot, and when set on the bench, the palm of the hand was brought down forcibly on the wooden knob *K*. This forced down piston *D* and squeezed the metal out through nipple *F*. Other machines were invented in the following years for making medals, sewing machine bobbins and various other small articles. The type-metal apparatus was also improved by such inventions as that shown in Fig 6, in which a much better design and arrangement were made of heating chamber, melting pot, cylinder, plunger, etc.

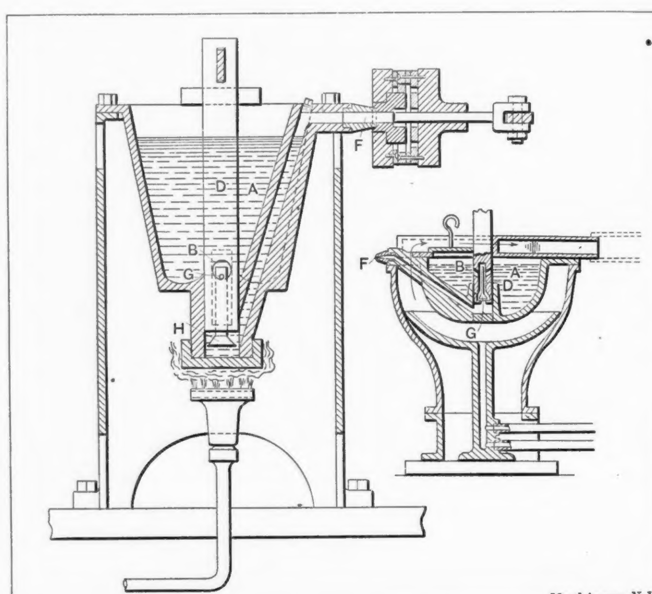


Fig. 5. Die-casting Machine patented in 1892. Fig. 6. Improvement made in 1888 on Machine shown in Figs 1 and 2

The first attempt to apply these principles to a more universal manufacture of castings, was made by C. and B. H. Dusenbury in the machine shown in Fig 4, which they patented in 1877. In this, the same principles as used on former machines were adopted for the melting pot, cylinder, plunger, outlet passage and nipple. In addition thereto, arrangements were made by which the die-molds that contained impressions for journal bearings were located on the machine, and exchanged for others when desired. Thus a wide range was given to the machine. The method of moving

* For additional information on die-casting machinery, see the following articles previously published in MACHINERY: "Die-Casting and Die-Casting Machines," May, 1911, engineering edition; "Die-Casting—1 and 2," January and February, 1911.

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the mold away from the nipple so it could be opened and closed was accomplished by the gear and rack.

Little was done with this method of casting until after C. W. Weiss was allowed some claims, on March 8, 1892, on practically the same machine that was patented by the Dusenburys in 1877. This is shown in Fig 5. From this time on, the die-casting business has steadily grown until it is now quite an important factor in the manufacture of many products. The many improvements have given us automatic machines that insert wires, bushings, clock wheels, etc., of steel, bronze or other strong metals, into the molds; then close them, cast the alloy, and eject the finished casting out of the mold. Between this and the simple hand-operated machine, there are belt-driven, motor-driven and semi-automatic machines used in the manufacture of die-castings.

Hand-operated Machines

The strictly hand-operated machines have been perfected to an extent that enables one man to turn out a large number of castings with an alloy that is not very high-priced. Thus a machine may be placed in a room or in any part of a shop where there is no power. The only thing required to operate it is a supply of gas to heat the melting pot and melt the metal, and a man. The output of these hand-operated machines is so large that it is only under very special conditions that the automatic machines can be economically operated. These conditions would require a very large number of castings from the same mold, and the castings

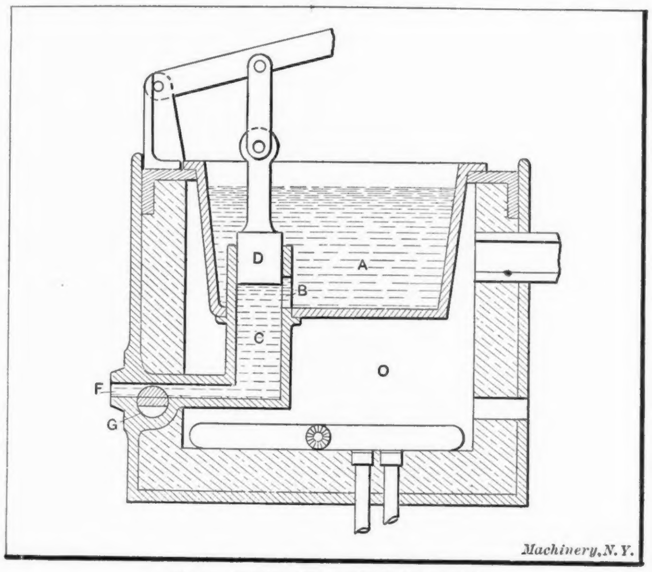


Fig. 7. Melting Pot with Side Outlet

could not be very intricate. With the hand-operated machines, however, very intricate castings can be made from the white-metal alloys generally used.

The modern hand-operated machine with its melting pot and method of forcing the metal into the molds has undergone many changes and has been the subject of a great deal of designing. In connection with it, valves and sprue-cutters have been made in several different ways. The ways and means of holding the molds for the cast and then opening, or parting them to eject the casting have also been improved in various ways. From the melting pot, the metal has been forced through the sides, top and bottom, and then into the molds. A cylinder and plunger has been the favorite method used and this has been designed in various styles and sizes. Some have used air for forcing the metal into the mold, but with no success.

Melting Pots and Plungers

In Fig. 7 is shown one of the latest styles of machines with the outlet from the melting pot in the side. In this, the burning gas in chamber *O* keeps the metal molten in pot *A* and it flows through passage *B* into pressure chamber *C*. From here it is forced by plunger *D* through nozzle *F* into the mold. Valve *G* is then turned over to stop up the passage and thus cut off the flow of metal. This style of machine brings the pressure chamber *C* down into the gas chamber where it is easily heated to the right temperature for casting. The metal that lies between valve *G* and the end of the nozzle *F*, however, has to be removed before it freezes and before the mold is opened. It is therefore necessary each time a casting is made, to move the entire mold away from nozzle *F*, while the sprue-cutter is in position for keeping the metal away from the casting. This extra metal then falls to the floor. This has been overcome in some machines, and hence one cause of trouble is removed. Another fault is that while plunger *D* is traveling past port *B* it forces the metal out into

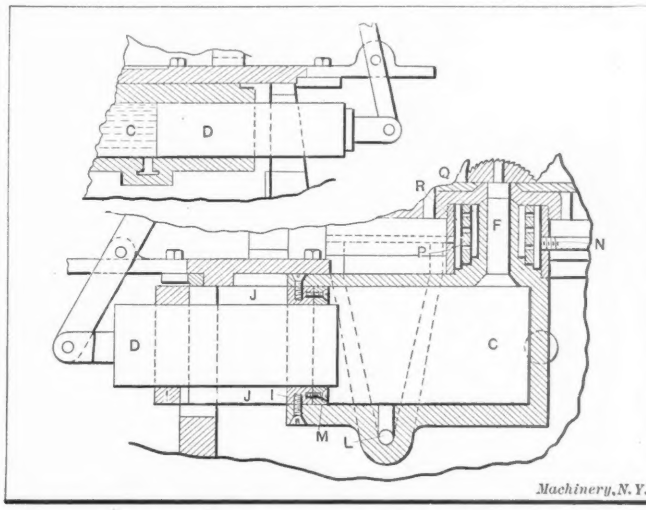


Fig. 8. Long Type of Plunger. Fig. 9. Plunger smaller than Cylinder—Auxiliary Heating Chamber for Outlet Passage

melting pot *A* and thus keeps it continually churned. This causes the dross and slag that should rise to the top to mix with the molten metal and enter the castings.

The plungers used with this type of machine differ considerably. The one shown in Fig 7, has a bearing surface as long as the diameter of the plunger. This "square" plunger gives very good satisfaction where it is covered with molten metal, as it is in this case. An extremely long plunger is shown in Fig 8. The construction of the machine is such that one end of the plunger comes out into the gas chamber, and therefore it was extended into the open air in order to overcome the excessive heat of the gas flames. Much trouble has been experienced with this type, from the metal freezing around the surface between it and the cylinder, thus causing the plunger to stick. This is largely due to the great difference in temperature between the two ends, and consequently plungers of this type have to be continually cleaned, as well as their cylinders.

To overcome this, the type of plunger shown in Fig. 9 was invented. It is smaller in diameter than the cylinder or

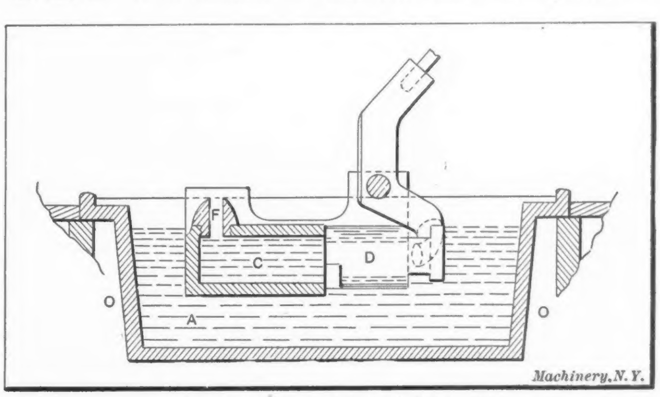


Fig. 10. Melting Pot with Outlet in Top

pressure chamber and travels in a rack composed of the two rings *I*, which are held together by ribs *J*. One of these rings fits into the end of the cylinder, and holds the rack in position. The molten metal flows into the pressure chamber through port *L*, and a valve closes this port when the plunger is brought forward to force the metal up into the mold. In the cylinder is located an asbestos washer *M*, for preventing any leakage of molten metal that might occur. This type of plunger largely overcomes the tendency of metal to freeze on the bearing surface, as its area is greatly reduced. Dross

also is not as liable to clog and stick the plunger in the cylinder. This design has, however, added the troubles encountered with an asbestos washer, which, owing to its non-cohesiveness, is continually crumbling away and flaking off.

Around the outlet or nozzle of this machine has been placed an auxiliary heating chamber. Gas enters through pipe *N*, surrounds the nozzle in passage *R*, passes through the perforated ring *P* and fills the inner chamber *Q*; after which the burnt gases pass out. This keeps the molten metal

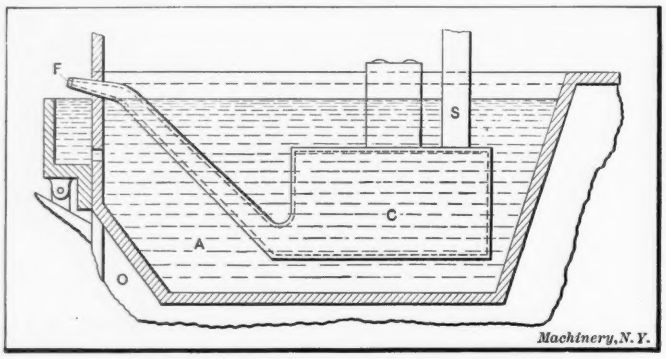


Fig. 11. Melting Pot with Air Pressure Chamber

that fills nozzle *F* from chilling when a casting is being made. This is one of the troubles often met with in this style of die-casting machine. Of course, when the sprue-cutter has severed the metal between the mold and the pressure chamber *C*, this passage empties when plunger *D* is pulled back. Passage *F*, however, is filled a large part of the time, as in making a casting it is necessary to bring the plunger forward as hard as possible, and hold it there while the mold is filling with metal and the sprue-cutter is being operated. Metal freezing in this passage causes a great deal of trouble which a heating chamber might abolish.

In Fig. 10 is shown another style of melting pot. This has a pressure chamber submerged in the molten bath, and the plunger is operated by a lever which passes out through the top of the bath. The nozzle also carries the metal through the top of the bath to the mold. In this type, the melting pot *A* is surrounded with gas flames at *O*, and the metal in the

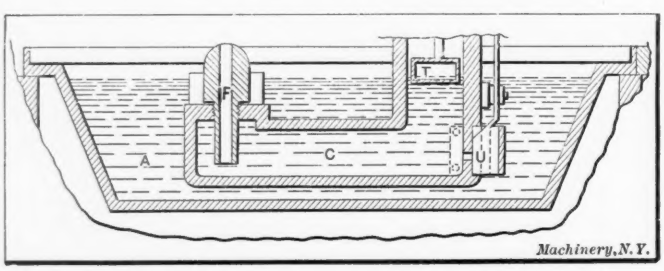


Fig. 12. Another Type of Air Pressure Chamber in the Melting Pot

pressure chamber has to be heated through the mass of metal in the melting pot *A*. It is therefore difficult to keep the metal in pressure chamber *C* as hot as that in melting pot *A*. The opposite condition should exist, *i. e.*, the metal should be hottest at the point where it is being forced into the mold. While several die-casting firms have used this type of machine, it has been the cause of much trouble.

Application of Compressed Air to Die-casting Machines

In Fig. 11 is shown a pressure chamber submerged in a melting pot, but instead of using a plunger, compressed air is driven into the pressure chamber through pipe *S*, and this forces the molten metal out through nozzle *F* and into the mold. This application of compressed air has appealed to many builders of die-casting machines owing to its simplicity of operation, its positiveness, and the fact that operating troubles, such as the plunger sticking to the cylinder, were overcome in the machine. All those who attempted it, however, were men who understood nothing of metallurgy or the nature of metals. With the exception of a few very rare elements, oxygen unites with every known substance. It has a special affinity for metals when heated, and the higher the temperature, the greater will be this affinity. It is one of the most injurious elements that can be injected into metals. By forcing air under pressure into pressure chamber *C*, as is done in this case, it is impinged directly upon the surface of the metal with considerable force, and thus greatly increases the amount of oxygen that the metal will absorb from this air. After the first few castings are made, the metal becomes full of small bubbles which increase in size with the number of castings made, and in a short time there is nothing to the casting but a shell of metal that is filled with bubbles. Many times such castings are marketed because the spongy formation of the center does not show on the outer surface, but the instant they are broken, their worthlessness is apparent.

In Fig. 12 is another type of the pressure chamber that is submerged in the melting pot, and thus has the coldest part of the molten metal passing through nozzle *F*, as is the case in Figs. 10 and 11. In this, air pressure has been used to force the metal up through nozzle *F*, but an attempt has been made to overcome the defects always encountered when using air. Float *T* has been placed in a compartment by itself, and the air is blown into this so that it will impinge upon the surface of the float, and only have a small surface of metal

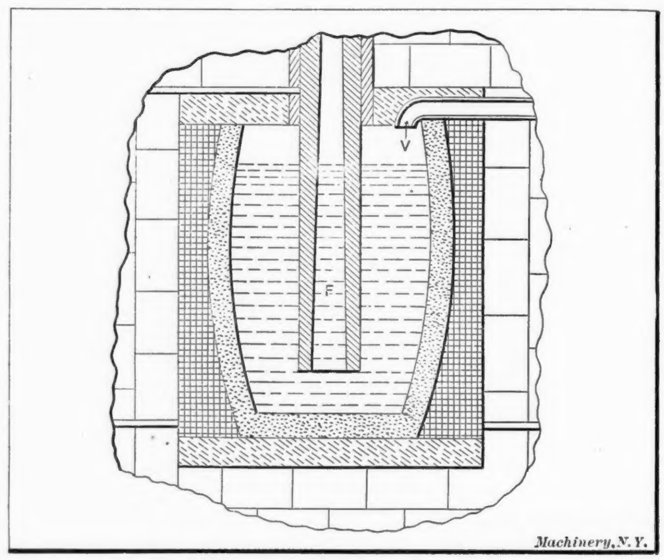


Fig. 13. Electrically Heated Crucible for Melting Pot

around the float to absorb the oxygen. Nozzle *F* was also made of a casting that projected close to the bottom of the bath in order to let out any bubbles and get only the densest metal in the pressure chamber. It was thought that the bad effects of air, or the oxygen in the air, would be overcome by causing it to travel downward and then across the pressure chamber to the nozzle *F*. While the bad features of air pressure were overcome to a certain extent, they could not be

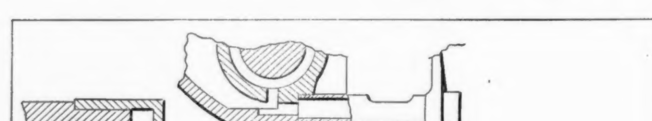


Fig. 14. Three Styles of Valves used

entirely avoided as long as any part of the surface of the metal was left free to be attacked by the oxygen in the atmosphere. Thus, while this machine will make quite a number of castings before the metal becomes charged with oxygen, it is still only a question of time when that will occur, and then the castings will be weakened and probably spongy and porous. An automatically operating valve was placed at *U*, so that pressure chamber *C* would take metal in as fast as it was injected into the molds.

Electrically Heating the Melting Pot

Another type of melting pot is shown in Fig 13. In this design an ordinary graphite crucible is surrounded with a resistance coil, and placed in a brick-lined receptacle. An electric current is then turned on to heat the crucible and metal. The top of the crucible was sealed, and air was injected through pipe *V* to force the metal up through nozzle *F*. While the electric heating arrangement is a good feature,

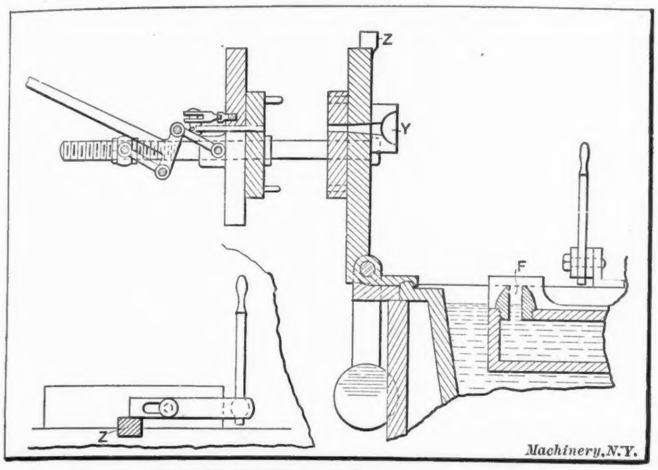


Fig. 15. Tilting Mold Table and Method of Parting the Mold

the air pressure attacking the surface of the molten metal would make this type a complete failure.

Valves

In Fig. 14 are shown three styles of valves which are used on die-casting machines. The one to the right, as can be seen, is cone-shaped and opens and closes the hole *W*. A sectional view through this hole is shown in Fig. 7 where the valve is marked *G*, and hole *W* represents outlet passage *F*. This valve is kept a tight fit by a spring located at *X*. It is easy to operate by connecting it to some of the other levers on the machine. The valve shown in the center of the illustration is operated automatically by chain and sprocket wheels, and closes its opening by turning half-way around.

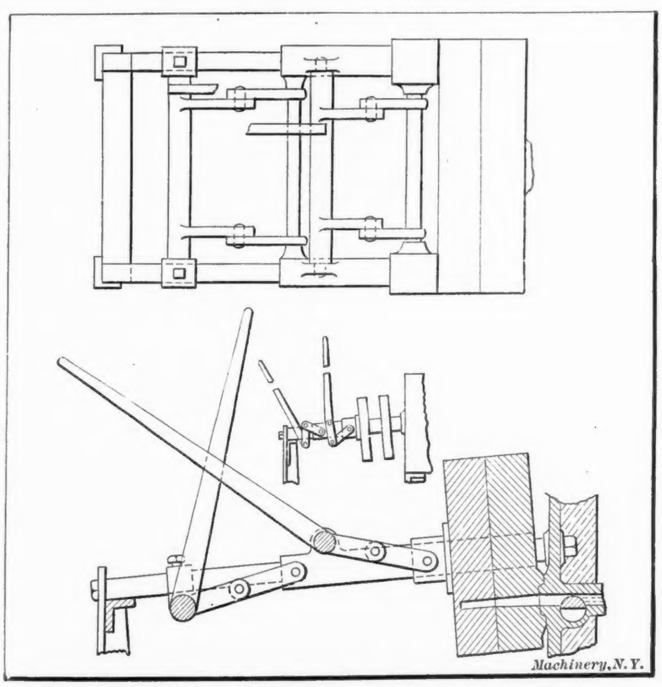


Fig. 16. Toggle-joint Arrangement for Parting the Mold and Drawing it away from the Spout

The bad feature of this valve is the large amount of surface which the molten metal comes in contact with, thus causing the valve to stick. The valve shown to the left is much more simple and has practically no wearing surface, it being merely a wedge shaped block that is forced into place by a beveled projection on a frame. This, however, can not be used in all places, and though its design is doubtless the best, its use is limited to the places where it can be operated.

Opening and Closing the Molds

The methods of holding the die-molds vary with the different styles of machines, and a large part of this variation is due to the different constructions previously shown. In the machines that eject the metal through the top of the bath, a platen is used on which to rest the mold, and these are usually fitted with tilting arrangements similar to the one shown in Fig. 15. In this machine, nozzle *F* is ball-shaped, and socket *Y* fits down over it when the table, with its die-mold, is in position for casting. The platen is clamped down by projection *Z* fitting under a piece that is moved by the upright lever, as shown by the sketch in the lower left-hand corner. The mold is divided into two parts. One part is fitted to a plate located on two rods that are bolted to the platen. A toggle-joint is then used to pull the two parts of the mold apart, so that the casting may be removed. This toggle joint is operated by the lever shown in the inclined position, and as will be seen, arrangements are made to take up any wear that might occur in this joint. The mold will thus be a perfectly tight fit at all times. This is a very important point in making die-castings, as the metal is squeezed into the mold under pressure, and if the joint were not a tight fit, this metal would squeeze out through the sides.

In Fig 16 is shown a method of holding the mold in position for casting on a machine that takes the metal out

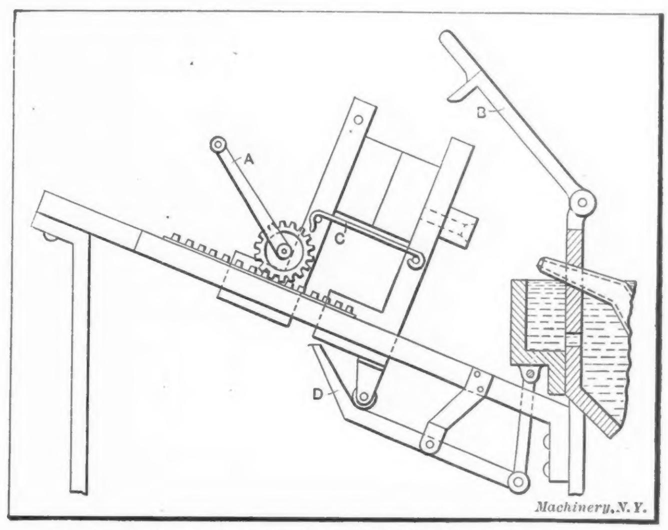


Fig. 17. Rack and Pinion used to part the Mold and draw it away from the Spout

through the side. One toggle-joint is used to close the two halves of the mold, while a second one is used to force the entire mold up against the nozzle. Why the toggle-joint, with all its faults, is used so much on die-casting machines is really a mystery, and yet it is probably due to the fact that the first machines invented were equipped with toggle-joints, and consequently nearly all designers followed this principle.

In Fig. 17 is shown a rack and pinion which is used for moving the mold away from the nozzle and also for parting it. In this illustration, lever *A* is used to operate the pinion which pulls the mold away from the spout. Hook *B* is then dropped down over the mold to hold it in position, while hook *C* is released and the two halves of the mold are pulled apart by the same gear and rack. In pulling the mold back, lever *D* is tripped and opens a valve that allows enough metal to flow into the pressure chamber to take the place of that which has been forced into the mold. While this tripping arrangement is good, and the gear, rack and pinion work successfully, the rest of the design is very crude, and it would mean very slow work in making castings. This machine, however, has not been commercially operated, and probably would not be without considerable re-designing. One of its worst features is the teapot form of pressure chamber with its air pressure. In Fig. 18, is shown still another method of opening and closing the mold, and clamping the two halves together. This also is crude and too slow in its operation.

Sprue-cutters and Ejectors

One of the necessary features on all die-casting machines that turn out perfect castings is the sprue-cutter. Two forms

of these are shown in Fig 19. The upper one is simply a rod that is pushed through the center of the casting. It implies that the casting has a center hole, and is very simple to construct and operate. If this hole is straight, it is immaterial whether it be round, square or any other shape. After the mold is filled, the sprue-cutter is pushed through it to separate the casting from the metal in the melting pot.

When castings have no center hole, the sprue-cutter can be placed at the end of the casting, as shown in the lower view. This mechanism makes it possible to stop the sprue-cutter at

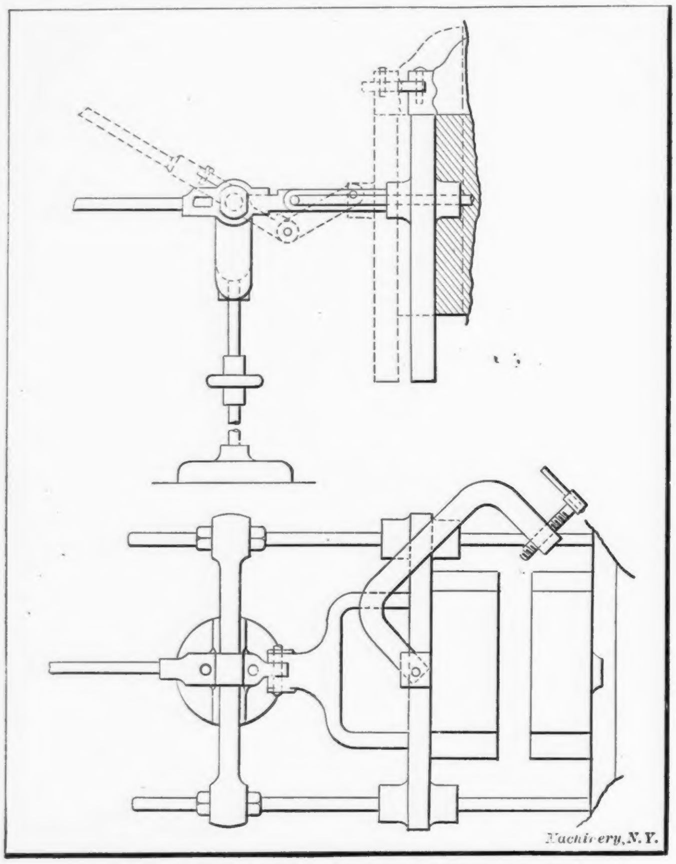


Fig. 18. Another Method of Opening and Closing the Mold

both ends of its stroke, the stops being adjustable to any position. The lever also gives the sprue-cutter, which must be a tight fit in the hole in which it operates, a straight push.

In another style of machine the sprue is cut with the platen, as shown in Fig. 20. In this, a piston working in the air cylinder *E* pushes platen *F* over far enough for outlet passage *G* to be out of alignment with the sprue hole in the mold, or the outlet in the lower part of the machine. This cuts off the metal, and leaves a pocket of metal in passage *G* which will equal the thickness of the platen. When it is held long enough for the casting to freeze in the mold, the metal in this passage will freeze and thus put the machine out of commission.

The principle of using air to operate different parts of die-casting machines, such as pressure levers, sprue-cutters, casting ejectors, etc., is very good; but considerable care in designing must be exercised to insure that no metal will be trapped in any part of the machine, and become solid. When this occurs it means that the machine must be taken apart and cleaned before it can be further operated.

In Fig. 21, is shown a casting ejector. This is fastened to one-half of the die-mold, and when the casting is complete and the mold open, the lever is brought down so that the small rods will push the casting out of the mold. The rods, of course, can be placed in any position desired, made of any size or shape, and are a very simple part of the die-casting machine. The casting ejector and the sprue-cutter must occupy positions very close to each other, and hence the levers that operate each one of these should be placed in easy reach of the operator.

Upright Die-casting Machine

In Fig. 22 is shown a complete upright machine that differs quite materially from the others shown. In this, the heating chamber, with its melting pot and pressure chamber, is supported on a cast-steel frame, and the molds are held directly underneath its center. The upper half *A* of the mold is fastened to the bottom of the heating chamber, and the lower half *B* is lowered away from it to get the casting out. The lower half of the mold rides on a cast-iron plate *C* which moves up and down on rods *D*. Lever *E* raises plate *C*, with its half-mold, by means of the toggle-joints *F*.

In operating the machine, the two halves of the mold are brought together tightly by pulling lever *E* outward. Lever *G* is then moved out to open outlet *M* of pressure chamber *H*, so that the metal will enter the mold. The lever *I*, which is above the machine, is pulled down to force plunger *J* downward, and thus squeeze the metal filling the cylinder, or pressure chamber *H*, into the mold. Lever *K* is then pulled up and forces the sprue-cutter *N* entirely through the upper half of the mold *A* and into the nozzle. Lever *G* is now pushed in to close the opening from pressure chamber *H*, sprue-cutter *N* pulled out with lever *K*, and the bottom half of the mold lowered by pushing in lever *E*. As this is done, small plate *T* beneath plate *C*, strikes plate *U*, which is supported from the base of the machine, and this causes casting-ejector *L* to push the casting out of the lower half of the mold. Hinged pieces *S* hold down the cover of the melting pot, so that when the two half-molds are brought together they will not raise the melting pot. One difficulty encountered with this type of machine is that of keeping outlet *M* free from molten metal, so that it will not drop on the casting and spoil it when the mold is opened for its removal. By making sprue-cutter *N* come up close to the metal cut-off *O*, this can be accomplished, but to make a tight fit of these two parts and keep it tight with the continued movements of the machine, while making castings, is not as easy as it looks. A very small drop of metal will often spoil the casting that is being made.

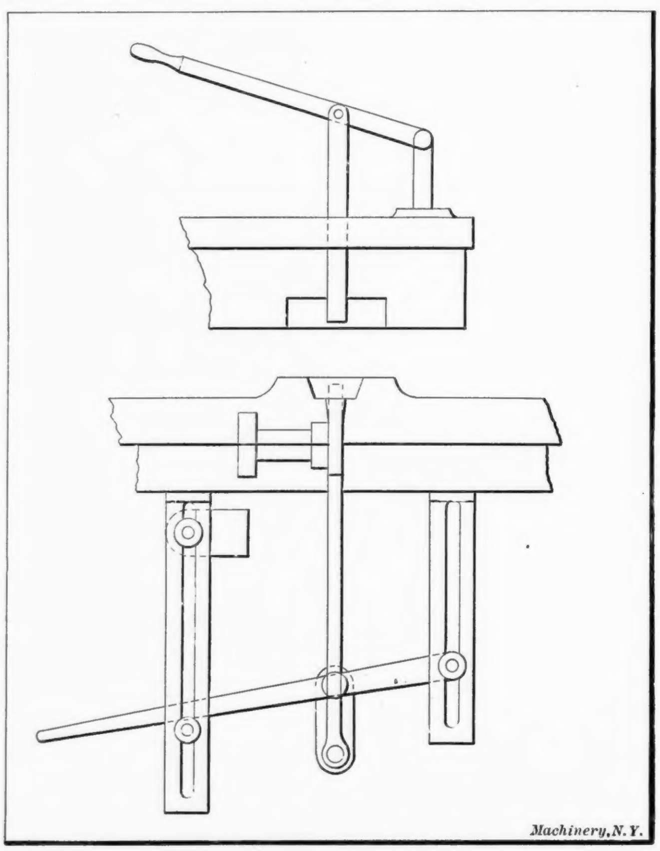


Fig 19. Two Forms of Sprue-cutters

Another bad feature is that the plunger *D* must move the distance shown by *P* before it forces the metal into the mold. While moving this distance it is squirting the molten metal out through ports *R*, and thus churning up the metal in the melting pot. This metal should be kept as quiet as possible. Another bad feature is that four levers must be moved independently for each casting that is made, and this makes the operation of the machine rather slow. These levers should be connected in such a way that the pulling of the two levers would be all that is required.

A machine of this type, however, could very easily be belt-

or motor-driven, and thus make its operation a boy's work. The work would consist of removing the castings and starting and stopping the machine. It could also very easily be made to operate automatically, and thus do away with even that much hand labor. The upright machine appeals to many on account of having the natural phenomena of gravity to assist in getting the metal from the melting pot into the mold. If the liability of molten metal dripping on the finished casting is overcome, this style of machine is very handy and easy to operate.

While many die-casting machines are made for belt or electric drive and semi-automatic or completely automatic, it requires an enormous output to make such a machine a paying proposition, for by gating the castings in molds a very large

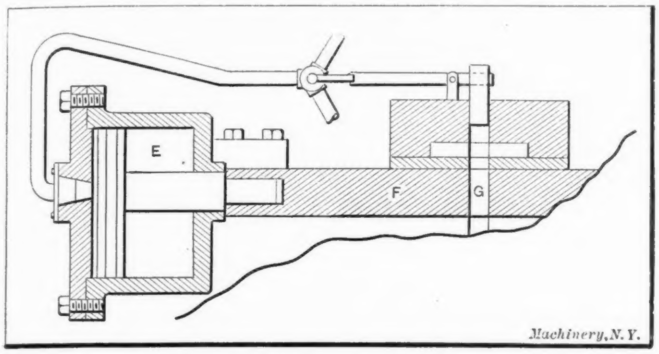


Fig. 20. Moving Platen to cut off the Sprue

output can be obtained with one man's labor on a hand-operated machine, but where thousands of pieces are to be made per day, the automatic machine will save this one man's labor, and can thus be made to pay.

Alloys for Pressure Castings

Many different alloys are compounded to make into castings in these machines. It is necessary to have an alloy with a fine, close grain that is free from porosity and low in shrinkage. Castings used for some purposes must have a high tensile strength and great hardness, and these can only be obtained at a sacrifice of ductility. Castings with a high ductility can easily be made, but the tensile strength and hardness must be sacrificed. This is also a general rule that applies to the

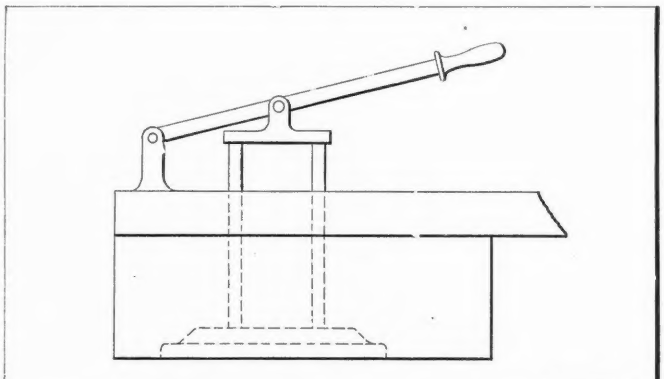


Fig. 21. Casting Ejector

manufacture and production of alloys and metals for all other purposes as well as die-castings.

Zinc, tin, copper, antimony, lead, aluminum, nickel, bismuth, magnesium and silver have been used and compounded in many different percentages to form alloys from which to manufacture castings. They have been used to manufacture castings for a large variety of purposes. The first five, namely zinc, tin, copper, lead and antimony are those most commonly used. Nearly any degree of strength, hardness, toughness, ductility, etc., can be obtained up to those inherent in the combinations that can be made. As yet, no one has marketed castings of the yellow metals or successfully made die-castings, on a commercial scale, from alloys or metals that have a melting temperature much above 1200 degrees F., or that have a strength equal to the bronzes. Considerable experimenting has been done and success is nearer than it was some years ago, even though the right method may not apparently be discovered.

Aluminum in small percentages is used in many of the die-castings. It acts as a purifier of the alloys, and causes it to flow more freely in the mold. To cast pure aluminum in die-molds or aluminum alloyed with small percentages of zinc or copper, or both, is very difficult. These alloys cannot be cast at all in very thin sections or with very fine detail in figured work, such as is produced in art castings. The lighter aluminum-magnesium alloys have also been experimented with, but these experiments have not met with much success as yet.

Much time and money has been spent by the different die-casting firms to die-cast manganese bronze, but this has been a failure, owing to the zinc oxide which forms on its surface when the alloy strikes the colder metal from which the die-mold is made. It is very doubtful if this feature can be overcome. One of the great difficulties encountered in casting metals of these comparatively high melting temperatures is the oxidization that the casting surface of the steel mold undergoes when its temperature is raised by the molten metal coming in contact therewith. This causes the mold to alter in

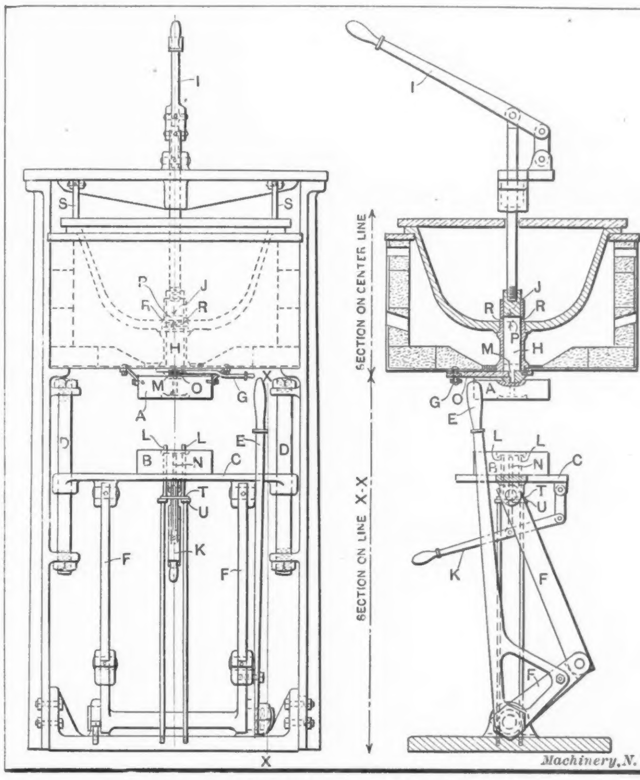


Fig. 22. Upright Machine for Making Die-castings

size and shape and thus destroy the accuracy of the castings. As this is an expensive way of producing castings, it is only by making them accurate as regards size and shape, and thus saving all machine work, that they can be made a commercial success. When this is done, however, the saving effected is so great that the die-casting machine and its products have become a necessity in manufacturing many parts of machines, instruments, etc., in the modern shop.

Aside from the die-castings made for bearings, zinc is the principal metal in die-casting alloys. An analysis of one of the most prominent makes of die-castings for use where no great strength or hardness was required showed 73.75 per cent of zinc; 14.75 per cent of tin; 5.25 per cent of copper, and 6.25 per cent of aluminum. Another prominent make that was used for similar purposes showed 72.70 per cent of zinc; 19.00 per cent of tin; 5.00 per cent of copper; 2.00 per cent of lead; 1.00 per cent of aluminum, and 0.30 per cent of antimony.

A die-casting that was somewhat harder than the two before given showed on analysis that the alloy was composed of 73.80 per cent zinc; 12.00 per cent tin; 10.60 per cent copper; 3.40 per cent aluminum, and 0.20 per cent iron, the iron being an impurity. Some very hard die-castings analyzed as follows: 46.20 per cent zinc; 30.80 per cent tin; 20.40 per cent copper; and 2.60 per cent aluminum. An alloy that was very high in zinc contained 93.00 per cent of zinc, 3.50 per cent tin, 2.00 per

cent copper, 1.50 per cent antimony, and 0.40 per cent aluminum.

[The sum of the percentages is 100.40. This anomaly is explained by the fact that after melting 93 pounds zinc, 3.5 pounds tin, 2 pounds copper, and 1.5 pound antimony, 6.5 ounces of aluminum is added as a deoxidizer.—EDITOR.]

Another alloy was composed of 90.00 per cent zinc, 6.00 per cent copper, 1.00 per cent tin, and 3.00 per cent aluminum.

While zinc and aluminum in certain percentages and under some conditions might make good die-castings, the aluminum cannot be very high or the alloy shows a tendency to disintegrate. An alloy composed of 50.00 per cent zinc and 50.00 per cent aluminum will disintegrate into a granular mass inside of a year. Such a mixture, even though possessing considerable strength at the time of casting, would very soon lose its strength and crumble up. Some of the die-castings made at present disintegrate, so that their strength is greatly weakened in the course of two or three years. This, however, is due to improper mixtures, as they can easily be made so that practically no disintegration will take place at all.

Zinc and tin mixtures also show an inclination to disintegrate, and hence some other material has to be alloyed with them to act as a binder. They are also inclined to be very brittle unless copper is added, and the molten metal thus given a greater ductility. The zinc and tin mixtures that contain a small percentage of copper are good for wearing parts and also for plating and japanning.

Antimony and bismuth have frequently been used in combination with lead to give the lead a greater hardness. Where no particular strength is desired, such an alloy can be used. The type metals that contain approximately 83.00 per cent lead and 17.00 per cent antimony have been cast in machines using steel molds for a number of decades. Practically all of the type metals such as standard, electrotype, linotype, etc., are easily manufactured into die-castings. These contain from 58 to 80 per cent lead, 4 to 25 per cent antimony, and 3 to 15 per cent tin. This gives a metal that is fairly hard and has considerable weight, but it is comparatively weak.

Alloys with high percentages of zinc, and a comparatively high copper content are very brittle, with little ductility and strength, while an alloy that is high in zinc and low in copper, *i. e.*, containing 90 to 92 per cent zinc and 8 to 10 per cent copper, shows a good resiliency and strength but no ductility.

Tin alloyed with lead and zinc casts freely and clean, and hence can be made to fill delicate parts of a mold. The zinc in die-castings usually runs from 70 to 90 per cent; the tin from 5 to 30 per cent; the copper from 2 to 20 per cent; the antimony from 1 to 5 per cent; and aluminum as high as 6 per cent has been used. While other metals have been used for making alloys for special castings, the ordinary casting can be produced from alloys made from these metals.

* * *

NEW ALUMINUM ALLOYS

In an abstract of a paper presented before the British Foundrymen's Association, which appeared in the *Daily Consular and Trade Reports*, mention is made of a new aluminum alloy. The result of adding aluminum to copper is to cause an immediate increase in both strength and ductility of the copper, the latter property reaching a maximum with 7.35 per cent aluminum. Beyond that point it falls, and when 11 per cent is reached the alloy is too brittle to be of any commercial value.

Heat treatment has little effect upon alloys that contain less than 7.35 per cent aluminum, but beyond that percentage they are stiffened by heat treatment at 1450 degrees F. Alloys with less than 7.5 per cent aluminum cannot be satisfactorily cold worked, though they are improved by hot rolling, while higher alloys are much improved by either hot or cold working. Such alloys show no tendency to age even after standing a couple of years.

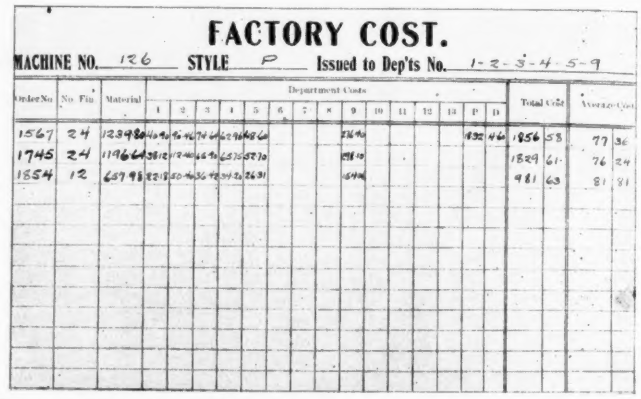
* * *

No man should be afraid of oil and grease while he is working around it, but that is no excuse for not cleaning up thoroughly when through with the day's work and before going into the streets.

A SHOP SYSTEM*

By M. M.

Much has been said in the columns of MACHINERY regarding shop systems, and for that reason, the writer takes pleasure in submitting a system of his own that is to be adopted in the works with which he is connected. It is a system that is anything but elaborate, being compact and concise, inasmuch as it puts all information regarding the affairs of the works under the complete control of the works superintendent, making him entirely independent of the various heads of departments in determining the progress of all work through these departments, and enabling him at a glance to



FACTORY COST.

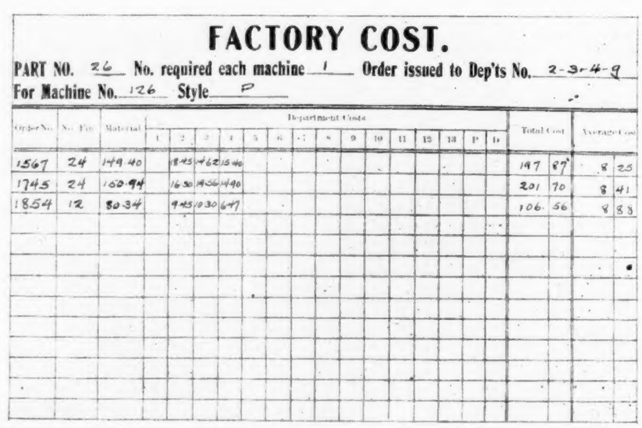
MACHINE NO. 126 STYLE P Issued to Dep'ts No. 1-2-3-4-5-9

Order No.	No. Fin.	Material	1	2	3	4	5	6	7	8	9	10	11	12	13	P	D	Total Cost	Average Cost
1567	24	1239.80	40.90	96.46	74.64	62.96	48.60				276.40					19.32	4.60	1856.58	77.36
1745	24	1196.64	38.12	112.40	66.90	65.75	57.70				298.10							1829.61	76.24
1854	12	657.98	22.18	50.46	36.42	34.20	26.31				154.08							981.63	81.81

Fig. 1. Superintendent's Office Reference and Record Card of Machine Costs

stop or push such work as is important or is wanted in a hurry, at the same time giving him an authentic record of all facts pertaining to the cost of material and labor, and other particulars of equal importance. Not only that, but in case of emergency, it assures a promise of any special delivery, rush order, etc., with an accuracy that cannot be denied.

The fundamental principle of the system is not building the completed machine as a unit, but building the machine by the part. Considering that all our machines are standardized and fully detailed with complete drawings of all parts, this can readily be accomplished, and means the grouping together of the equipment in batteries best suited to handle



FACTORY COST.

PART NO. 26 No. required each machine 1 Order issued to Dep'ts No. 2-3-4-9
For Machine No. 126 Style P

Order No.	No. Fin.	Material	1	2	3	4	5	6	7	8	9	10	11	12	13	P	D	Total Cost	Average Cost
1567	24	149.40		18.45	14.62	15.40												197.87	8.25
1745	24	160.94		16.30	19.56	14.90												201.70	8.41
1854	12	80.34		9.45	10.30	6.47												106.56	8.88

Fig. 2. Superintendent's Office Reference and Record Card of Parts Costs

the work along these lines without any undue shifting around of material, keeping it in the correct rotation from department to department in succession until finally brought to the assembly. To do this the following departments known by number have been established:

D Drafting-room;
P Pattern shop;
1 Planer, boring mills and large radials;
2 Lathe;
3 Milling machine;
4 Shaper and drill press;
5 Tool and die making;
6 Grinding;
7 Experimental;
8 Small part assembly;
9, 10, 11, and 12 Assembly;
13 Miscellaneous.

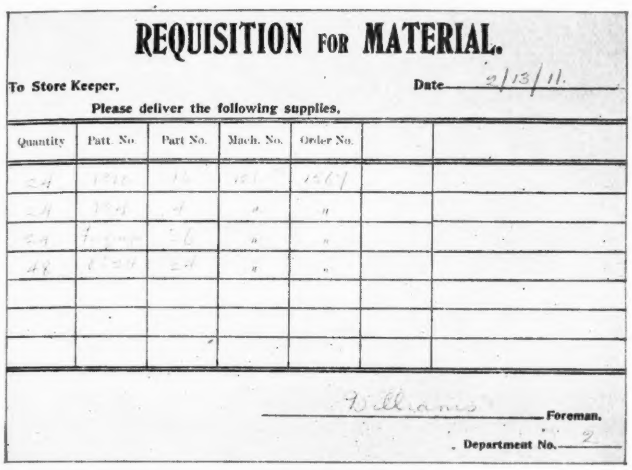
* For additional information see "A New Shop System" in five installments, March and April, 1898, and May, June and July, 1899.

The assembly departments, 8 to 12 inclusive, are equipped with the necessary small machine tools.

The mode of procedure is as follows: The sales department issues its order to the superintendent in the customary manner for a given number of machines of a certain type; all machines are known by number. The superintendent then secures from the drafting department a complete set of blueprints showing all the details, and from which the orders calling for these parts are issued to the various departments.

The following is a list of blanks and cards to be used, and which are herewith illustrated:

Fig. 1. Superintendent's office reference and record card of machine costs.
Fig. 2. Superintendent's office reference and record card of parts costs.



REQUISITION FOR MATERIAL.

To Store Keeper, Date 2/13/11.

Please deliver the following supplies,

Quantity	Patt. No.	Part No.	Mach. No.	Order No.		
24	[illegible]	[illegible]	[illegible]	1567		
24	[illegible]	4	"	"		
24	[illegible]	26	"	"		
48	[illegible]	24	"	"		

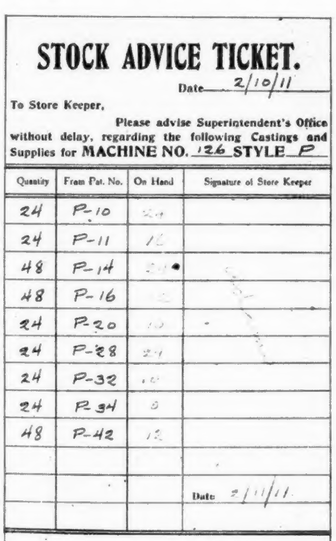
Williams Foreman,

Department No. 2

Fig. 3. Requisition Blank

Fig. 3. Requisition blank.
Fig. 4. Superintendent's office stock advice ticket.
Fig. 5. Identification tag.
Fig. 6. Department shop order.
Fig. 7. Department partial shop order ticket.
Fig. 8. Daily time ticket.

When the superintendent receives the order for the machines, he will cause the order number to be recorded on a card like that in Fig. 1; eventually this card will contain a full record of all costs of the machine; it is known as the "Machine Factory Cost," and is printed on blue paper so that it may be readily recognized. This card is ruled into columns, and will contain, as before stated, all factory particulars, including the number finished, cost of material, cost of every department that has any work in connection with same, and finally the total cost of the order and the individual cost of each machine. Each successive order is recorded on this card, and a ready comparison of the fluctuations in operating expenses for departments are immediately noted for investigation with a view to ascertaining the causes.



STOCK ADVICE TICKET.

Date 2/10/11

To Store Keeper,

Please advise Superintendent's Office without delay, regarding the following Castings and Supplies for MACHINE NO. 126 STYLE P

Quantity	From Pat. No.	On Hand	Signature of Store Keeper
24	P-10	24	
24	P-11	12	
48	P-14	[illegible]	
48	P-16	[illegible]	
24	P-20	[illegible]	
24	P-28	24	
24	P-32	[illegible]	
24	P-34	0	
48	P-42	12	
			Date 2/11/11

Sup't.

Return to Superintendent's Office.

Fig. 4. Superintendent's Office Stock Advice Ticket

The parts of each machine are numbered in rotation, and a separate record, as in Fig. 2, printed on yellow paper is kept of each in connection with the blue card above. This "Parts" card will eventually contain a full record of departments that handle the part, its weight, cost of material, costs of each department, and also the total and individual or average cost per part. Each successive order is recorded the same as on the card above, and the loop-holes in manufacturing due to negligence on the part of foreman or operator are immediately shown by the comparison of costs of labor, etc., in each department.

The large and heavy castings that represent the main parts of the machine are never kept in stock, and so are provided for immediately by the superintendent on a requisition blank like that in Fig. 3, sent to the purchasing department. These blanks are made up in book form, four on a page; they have perforated edges, and are made in duplicate, the copy remaining in the book as a part of the superintendent's record.

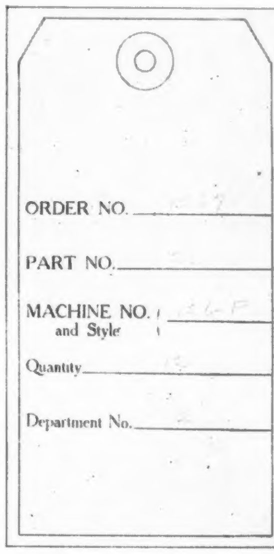
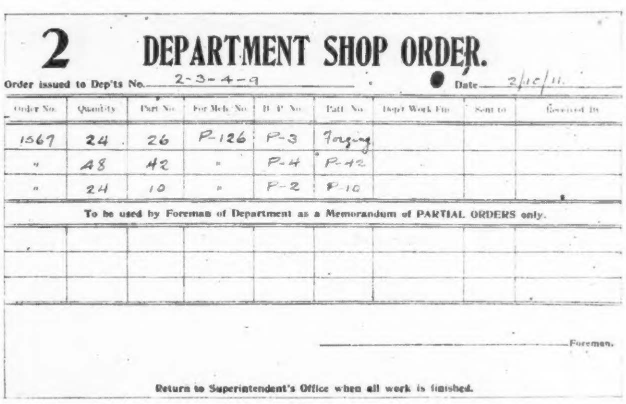


Fig. 5. Identification Tag

For the smaller parts or castings, the superintendent causes the list shown in Fig. 4 to be sent to the store-keeper. This list, which is printed on flexible paper, and put up in pad form, gives all particulars, and asks for the information indicated. The store-keeper, on receiving it, ascertains the number of parts or castings he has on hand as requested, fills in the date, signs, and returns immediately to the superintendent's office. Upon the advice thus received, the balance of supplies, if any, are immediately ordered by the superintendent through the purchasing department, using the blank before described, Fig. 3. By adopting this plan, a check is kept on all castings and supplies, which prevents the continual accumulation of such supplies, a condition that would occur if they were ordered on each successive order without first ascertaining whether or not any stock was available.

The parts being all provided for through the superintendent's office, department shop orders, Fig. 6, are now issued to the various departments for all the parts to make up the completed machines. These orders have the number of the department printed in heavy black type in the upper left hand corner, and are printed on flexible paper (preferably white), so that they may be typed in multiple, to include all the departments handling or machining that particular part. As illustrative of its operation, an order is issued for 25 crankshafts for a certain style of press; orders are issued to departments 2, 3, 4, and 9. The lathe department No. 2 handles the work at the beginning; the milling department, No. 3, handles it after No. 2; and so on. Similar orders are issued to the first three departments, the orders being distinguishable by the number representing the department printed in the upper left-hand corner as above stated. A separate order, similar to the others, calling for the number of the complete machines, is issued to department No. 9, the assembly department of this type of machine. Consequently all parts machined eventually find their way to the assembly.



2 DEPARTMENT SHOP ORDER.

Order issued to Dep'ts No. 2-3-4-9 Date 2/10/11.

Order No.	Quantity	Part No.	For Mch. No.	B. P. No.	Patt. No.	Dep't Work Fin.	Sent to	Received by
1567	24	26	P-126	P-3	Forging			
"	48	42	"	P-4	P-42			
"	24	10	"	P-2	P-10			

To be used by Foreman of Department as a Memorandum of PARTIAL ORDERS only.

Foreman.

Return to Superintendent's Office when all work is finished.

Fig. 6. Department Shop Order

Upon the receipt of this order by the head of department No. 2, or the department that first handles it, a requisition on the store-keeper is issued on a blank similar to that shown

in Fig. 3, for the number of forgings required to fill the order, and as they have been provided through the superintendent's office, they are sent up to him, having a red tag, as in Fig. 5, attached to one of the lot to identify them. This tag contains all particulars as to quantity, part number, machine and style, and order number. As the work is completed in this department, this same tag or a duplicate is attached to one of the crankshafts already machined, and sent to the next department handling the same, which in this case is No. 3. The same procedure applies in this department; the work is then sent to the next, which is No. 4, with the red tag still attached. This department, in turn, sends the shafts when finished to the final department, No. 9, which is the assembly. Should one of these crankshafts, by any mischance, be spoiled or incorrectly machined through an error on the part of some mechanic, this system compels the foreman of the department to report this fact immediately to the superintendent, thus causing an investigation to be made as to how it happened, whether through negligence or accident, and gives no opportunity for anyone to quietly scrap it without the full knowledge of the superintendent. As the work is finished in each department, the shafts are sent on, the head of department sending them to the head of the next department, who acknowledges their receipt by signing his name in the space provided on the department shop order, at the same time filling in the date. This compels the receiving foreman to verify the number of pieces so that it tallies with the number on the red tag, Fig. 5. After obtaining the signature of the next department foreman, the shop order is returned to the superintendent and is filed, until all departments having any handling of this part have turned in their shop orders. All labor being completed on the part, the costs are transferred to the factory cost ticket, Fig. 2, which is then a complete record of actual costs.

At various times, through the crush of work and orders piling up, it may be found to be good policy in some departments, to make up only a part of the order. To record this, another blank, Fig. 7, called the "Partial Order Ticket," printed on brown paper is used by the head of the department in lieu of the regular department shop order, and after going through the same routine as the original order, being signed by the foremen of the departments, is turned in to the superintendent's office. As this is done the fact is recorded on the original shop order in the space provided for this purpose; this acts as a constant memorandum of parts still due

2

PARTIAL ORDER TICKET.

Order No.	Quantity	Part No.	For Mch. No.		Dep't Work Fin.	Sent to	Received By

_______________ Foreman.

To be used for ONE ITEM ONLY when impossible to finish up full number of Parts on Dep't Shop Order. Return to Superintendent's Office.

Fig. 7. Department Partial Shop Order Ticket

on the original order. Each department, in turn, on completion of the work to be done turns in a similar ticket to the superintendent; these are in pad form as issued to the heads of the departments. This partial order ticket as it is turned into the superintendent's office, forms part of the record and shows what progress is being made on this particular part through the works. The adoption of this plan enables the superintendent to take steps to push through and direct what parts are to be rushed, and avoids the holding up and delaying of parts in the various departments, for he has the information at hand to locate the part by looking up its department shop orders that have been returned to his office.

A "Daily Time Ticket" as shown in Fig. 8, is an absolute necessity. It is ruled and printed, as shown, provision being made for all particulars of both stock and time; it also forms part of the superintendent's record. These are collected daily and filed in respective order number rotation, and upon completion of any department shop order, all information is transferred to factory cost cards as before described. This daily time ticket is an important factor in determining actual costs, etc.

To sum up, a system such as this one is automatic in operation, and has much to commend it: First, there is a complete and actual record of labor costs by department; second, a constant check is kept by comparison and a means provided for locating any excessive expenditures due to negligence,

2

DAILY TIME CARD.

Date 2/13/11.

Employe's No. 156 Name J. Brown

Order No.	Part No.	TIME	Description	Rate	Cost	
1543	14	1	Finishing Studs	30		30
1622	8	3	Facing Castings	30		90
1567	26	6	Turning Crankshaft	30	1	80
Order No.	**Part No.**	**Weight**	**Material Only**		**Cost**	
1543	14	20	C.R. Shafting	4		80
1622	8	56	Cast Iron	3	1	68
1567	26	415	Forgings	18	74	70

Approved by R Sup't. Williams Foreman.

Fig. 8. Daily Time Ticket

incompetent help or other conditions; third, the cost of each individual part or piece of every machine is recorded—information that can be advantageously used in computing cost of duplicate parts when needed; fourth, there is correct tally of material used for both part or machine, and actual cost of each; fifth, an additional feature is that after a complete record of all parts and machine have been established on the factory cost cards, Figs. 1 and 2, and the department shop order, Fig. 6, the information is all there to facilitate the issuance of any further orders for similar parts, by merely referring to them as a copy or reference.

* * *

The Buffalo & Allegheny Valley division of the Pennsylvania Railroad has arranged to compensate employes for suggestions relating to increased efficiency of operation or safety of passengers and employes, which upon investigation prove to be of sufficient value to warrant adoption. The suggestions need not be confined to the immediate duties of the employe or the department in which he works. Those which will be considered must embody ideas that have for their object one or more of the following ends: They should tend to increase the efficiency or improve the methods of operation; they must be beneficial from an economical standpoint, increase the safety and convenience of passengers and the safety of employes, increase the patronage of the company, or in any way promote the interests of the company, and may involve the use of new methods or modification of old ones. The suggestions must not contain personal complaints.

* * *

Fourteen 14-inch guns, costing over $127,000 each, with mounts, are now in process of construction at the Washington Navy Yard for the new battleships *New York* and *Texas*. The remaining six guns required to complete the two batteries are being built by the Midvale Steel Co. and the Bethlehem Steel Co. The length of the new guns is 53 feet 6 inches; weight, over 63 tons; powder charge, 365 pounds; weight of shell, 1400 pounds; muzzle velocity, 2600 feet per second; muzzle energy, over 73,000 foot-tons; effective range, 12 miles; cost of firing one shot, $700, exclusive of deterioration of gun; life of gun, 225 shots before relining is necessary. The cost of one gun exclusive of the mount is $74,700, the cost of the mount being $53,000.

MODERN CAN MANUFACTURING*

By HART PRESTON

Swift & Co., Chicago, distribute among stock-yard visitors a pamphlet describing its various methods and products, on the back cover of which is the head of a pig with the inscription "*nothing lost but the squeal.*" Aside from the packing industry and the Standard Oil enterprise, this expression can scarcely be more truthfully applied to any other line of manufacture than to that of tin cans. While many new inventions and perfected methods have practically revolutionized the can-manufacturing industry during the past decade, two factors are constantly bringing out new ideas and labor-saving equipment for this line of manufacture, one of these being *competition*, and the other, *progressiveness*. It may be of interest to state here that one concern in the tin-can business charges to profit and loss each year, an average of $75,000 expended for experimental work along these lines.

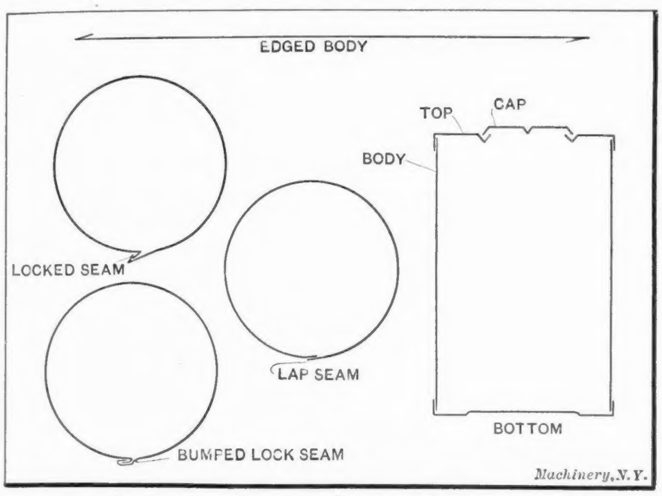


Fig. 1. The Seams used, and the Component Parts of a Round Can

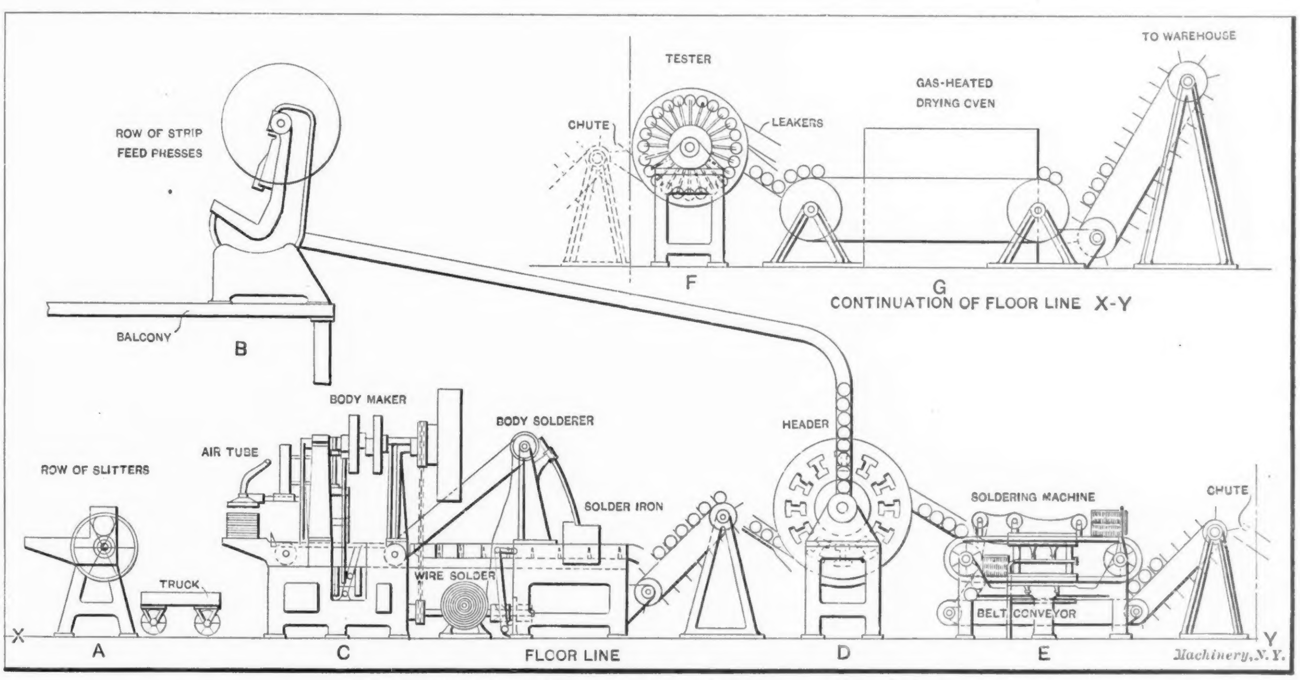


Fig. 2. Automatic Equipment used in the Manufacture of Round Cans

This item, however, is offset by a much larger figure in reduced labor and manufacturing costs.

Automatic Production of Round Cans

One of the most interesting processes of can-manufacturing is the rapid, automatic manufacture of fruit or packers' cans, which is the style of can used in the greatest quantities—for canning peas, tomatoes, corn, soups, condensed milk, peaches, pears and other fruits, vegetables and liquid canned products. Packers' cans are made in what the trade specifies as 1-pound, 2-pound, 2½-pound, 3-pound and 10-pound, or gallon cans, which increase in diameter in the order outlined, and which with the automatic equipment outlined in Fig. 2, are produced at an output of from about eighty of the gallon to about one hundred and ten of the one-pound cans per minute, or approximately fifty thousand cans per day. This output is the demonstrated normal working capacity of each of the various automatic machines required in the manufacture of the completed can, as shown in the group Fig. 2. These automatic machines have not only eliminated about eighty per cent of the number of operators formerly required for producing the same volume of work, but they also turn out neater and more dependable work.

Slitting and Trimming Machines

Each packers' can, as shown in Fig. 1, has four composite parts, *viz.*, body or cylinder, bottom, top and cap or center-plug for top, the cap, of course, being applied at the canning factory after the cans are filled. The body, top and bottom are all made and assembled automatically with the exception of removing the stock sheets of tin from the boxes, and reducing the sheets to blanks of the proper sizes in the gang slitting and trimming machines shown at *A* in Fig. 2. These gang slitting machines have a gang or group of circular cutters or knives operating in pairs, one on the upper and one on the lower shaft, the shafts being geared to each other and operating at the same speed, to insure accurate feeding and discharging. The knives are adjustable inwardly for trimming the edges or sides of the stock sheets and slitting or cutting them into strips of the various widths required. About four slitters are required for each group of machines as shown displayed in the "line" in Fig. 2. One of the slitters is used for trimming and splitting the sheets into strips of the proper width for the bodies, the full length of the stock sheet. Another takes these strips and cross-cuts or splits them into accurately sized blanks for the bodies; while the other two machines trim and split the sheets into strips for the tops and bottoms, which are cut out in the automatic strip-feed press shown in Fig. 3, and also at *B* in Fig. 2. For brevity let us hereafter specify "tops" and "bottoms" under the can-maker's common classification of "ends."

Automatic Strip-feed Press

The automatic strip-feed press shown in Fig. 3, is an open-back inclinable press, equipped with change-gears and automatic feeding devices, the latter being adjustable for various lengths of feeds according to the diameter of ends to be cut. This press is entirely automatic in its operation and runs continuously, all that is required of the operator being to keep the feed-table properly supplied with strips of the proper

* For additional information on can-making machinery previously published in MACHINERY, see "Making Solderless Cans for Food Products," September, 1909.

size, which come directly from the slitter. This press is equipped with automatic vacuum or suction feed provided with an automatic opening and closing valve, the action of which, together with that of the side-feeding arms, is controlled by the gearing shown on the left-hand side of the press.

The vacuum feed sucks or lifts one strip at a time up from the stack, carrying it up to a back-gage, at which point the valve is closed and the strip drops onto a lower plate attached to the side-feeding arm. This side-feeding arm, which is actuated by the cam and train of gears, automatically carries or feeds the strip forward into the dies the required distance at each stroke of the press. By the time the last end or blank

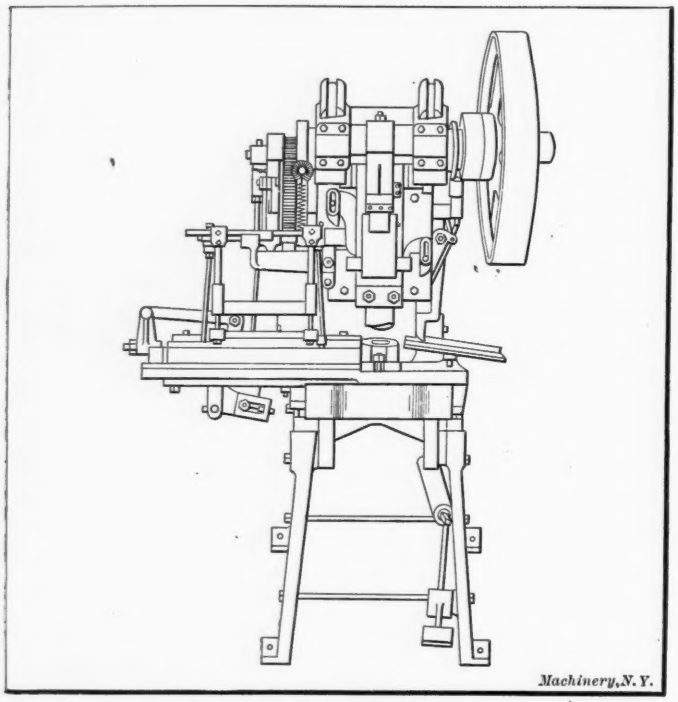


Fig. 3. Automatic Strip-feed Press

is cut out of the strip, the vacuum-feeding arms nave again come forward, picked up another strip and the operation continues uninterruptedly. Each strip of scrap is automatically ejected or discharged at the side of the press by the finger provided for that purpose, which is operated by a toggle-motion governed by a small cam attached to the right-hand side of the frame, as shown in Fig. 3. The ends or blanks themselves "clear" or fall away from the dies by gravity, the presses being inclined or set at an angle. From this press the ends are conveyed through the chutes or conveyors to the header D, shown in Fig. 2. Several of these automatic strip-feed presses are required for blanking a sufficient quantity of ends to keep up with the speed of the machines performing the later operations on the can.

Body-making and Soldering Machines

While the ends are being cut and formed, the bodies or cylinders are being automatically edged, formed, bumped (see Fig. 1) and soldered in the body-making machine shown at C in Fig. 2. This machine is also equipped with an automatic vacuum feed, each strip having been previously prepared in the slitter to the exact size required for producing one body or cylinder. The vacuum feed sucks or lifts up one sheet at a time from the stack and deposits it in front of a set of feed-fingers, which carry the flat blank under and against a set of edging jaws, one of which is located at each side of the machine. These edging jaws automatically form the hooks or laps on the two sides of the blank, as shown in Fig. 1, when the blank is again carried forward in a similar manner, to the forming horn or mandrel, over which by means of two swinging jaws, the blank is formed or rounded and the hooks or laps are joined and bumped or clinched together. The body is then carried farther along this mandrel under a gas-heated elongated soldering iron or shoe of sufficient length to fully cover the entire length of the side-seam on the longest can body within the limit of the machine. This is to insure a ready flow and application of solder the full length cf the seam.

The solder is fed to this soldering iron by an automatic cam-actuated feeding and cutting-off device, which feeds the wire solder directly from the reel to the machine, the cutting-off attachment having adjustment to suit the various sizes of "drops" or chips of solder required for the seams on the different lengths of bodies. Although, as stated, the solder cutting-off device is adjustable, the solder does not always flow uniformly, and therefore, at times forms a thicker coating at one point than at another. Also, in order that there may be enough solder applied to properly fill up the side-seam, it is necessary to cut off a trifle more solder than is actually required. To prevent losing this excess amount, an adjustable brush (which does not revolve) wipes or brushes off this surplus solder before the formed and soldered body finally drops into the conveyor, the latter carrying it to the heading machine, shown at D in Fig. 2.

Header

In the header, the bodies and ends are all brought together by means of the conveyors shown. As the bodies fall into place in the header-forms or jaws, they are followed an instant later by the ends; the header then automatically snaps the ends onto the bodies, slightly clinching or crimping the rims of the ends onto the bodies. This is accomplished by an eccentric on the end of each header-form or jaw, which is gradually forced inward and downward as the rotary motion of the machine carries these eccentrics against a set of cam rings attached to the frame of the machine itself. These machines are very simple, yet so positive in their operation that they even shape or round bodies which may be slightly distorted upon coming into the header.

It should be stated here that the header, as well as the body-maker and the other machines in the group, is adjustable to take in the various sizes of cans from the one-pound to the gallon size. The adjustments and changes on the various machines require from ten to twenty minutes. However, where the "line" is not run continuously on one particular size, they usually run for several days at least on a "run" or quantity of one size, and the changes are made at "off-hours" so as to insure operating each machine the maximum period during regular working-hours.

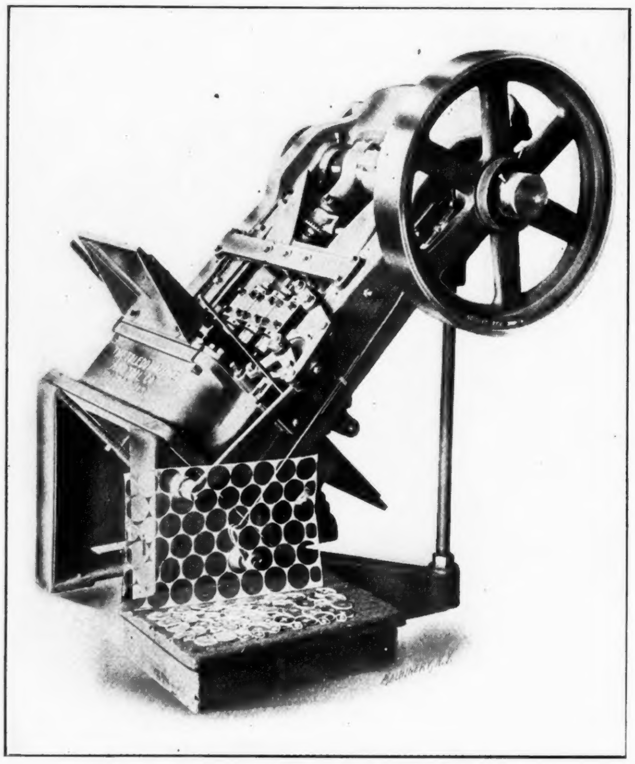


Fig. 4. Double-crank Press fitted with Gang Dies

End-soldering and Wiping Machines

Ejected from the header, the can is delivered by a conveyor to the end-soldering machine or floater shown at E in Fig. 2. Here the solder is applied to the top end or joint

as the can is being carried along or "floated" through the solder trough or bath situated along one side of the machine. After one end is soldered, the can is automatically inverted and carried to the other or lower side of the floater, where the bottom joint is soldered. The cans are rotated or kept in motion as they are carried through the solder trough by means of the friction imparted by moving chains, which lightly rest on and rub against the top surface of the can.

In this machine also care must be exercised not to waste any solder (one of the most expensive can-making supplies), as the circular motion of the can picks up and causes to adhere to it an excessive amount of solder; so after the top is soldered and before the can is transferred to the other side of the floater, the can is carried through the end solder-wiper shown at E in Fig. 2. This wiper by means of brushing-rolls which revolve at a high rate of speed removes the solder.

These solder wipers are now to be found in almost every can factory of any size, and although few of them sell at less than $500 it is a demonstrated truth that where used continuously, they wipe off sufficient surplus solder to easily pay for themselves within three to six months. As a further illustration of the actual merit and manufacturing cost-reducing value of these solder wipers, it is interesting to note that several manufacturers of these machines refuse to sell them, but merely lease them to can-makers on a royalty basis, computed on a fixed percentage for each pound of solder the wiper saves the can-manufacturers per year—and a great number of them are leased.

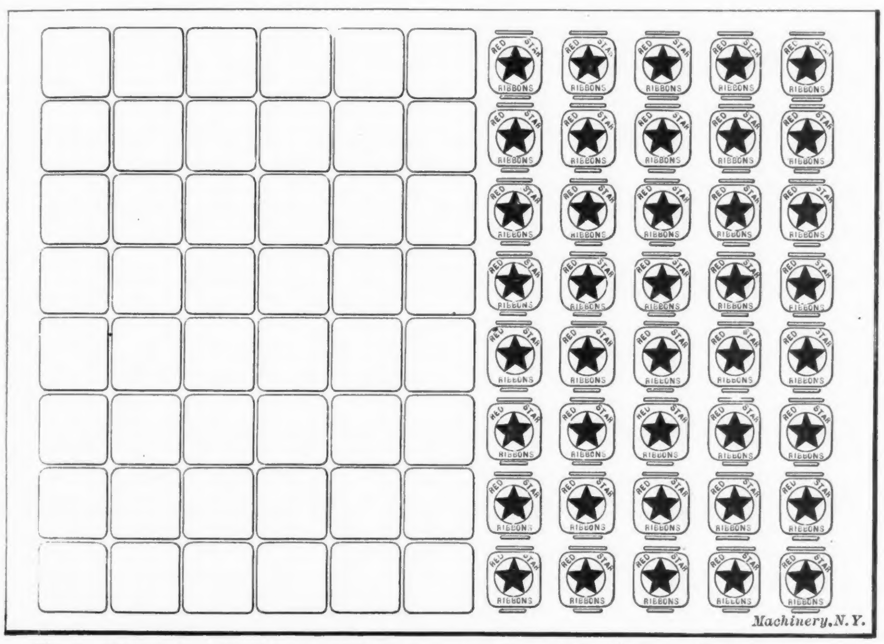


Fig. 5. Lithographed Sheet from which the Covers for Fancy Colored Square Cans are cut

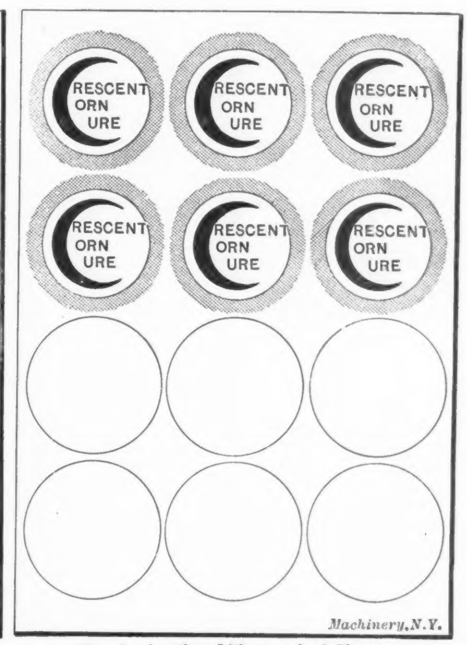


Fig. 6. Another Lithographed Sheet

Tester

From the end-soldering machine, the soldered can is conveyed to the tester, shown at F in Fig. 2, into which the cans are automatically fed, located, tested, and at the proper time, discharged either into the "good" or the "leaky" can chute. Most testers have a rotary motion, being either of the horizontal or upright design similar to a ferris-wheel. A pressure of from twelve to fifteen pounds is sufficient to detect the most minute leak. All modern testers use air-pressure for testing purposes. A separate feed-pipe or air-tube leads from the center of the main cylinder to each testing diaphragm or chuck, and if there is a leak in a can the valve in the chuck automatically closes, and throws out a little trigger or finger attached thereto, which during the travel of the main-frame automatically opens the chuck at the defective chute and drops the can into the latter.

If the can is good (not leaky), the trigger remains in position, and the valve is closed until the can reaches the good chute, when the pressure is for a moment automatically released, the chuck opened, and the cam dropped into the chute. Many can-makers use air exclusively for testing cans, while some of the most experienced still use the extra precaution of immersing the air-filled can in a vat of water. They claim for this that an experienced and watchful operator will more readily detect almost unnoticeable leaks, which would probably not be caught in an ordinary air-tester owing to the fact that the pressure is not applied through a long enough period, although this same pressure will instantly produce bubbles—the can-makers' "trouble-finder"—if the air-filled can is immersed in water.

Gas-heated Drying Oven

When cans are immersed in water it is necessary to thoroughly dry them before shipping, to prevent rusting. This is accomplished by conveying the cans from the tester to a gas-heated dryer or oven, as shown at G in Fig. 2, through which the cans are carried on a slow-moving conveyor. From this oven the cans are transported by carriers either directly into the cars or to the warehouse. So it will be seen that it is a literally true statement that from the time the blanks or strips for the various can parts are cut to size and fed into the first forming machines, no hand touches the cans until they reach the canning factory.

Gang Die Work

As strip-feed presses can only be economically employed on work up to about 4 inches in diameter, owing to the small "mill sizes" for standard sheet tin and the consequent comparatively short lengths of strips that can be cut from them, the larger diameter ends are usually produced in double-crank presses as shown in Fig. 4. These double-crank presses are fitted with gang or group dies by means of which a whole sheet of tin is cut up into various diameters of ends and caps at one stroke of the press (caps are almost universally produced with gang dies), the "cuts" for which are usually so gaged or laid out as to produce the greatest number of cut pieces, or, in other words, reduce the "scrap" or unused portion of the sheets to a minimum. Presses fitted with gang dies are usually mounted on inclined legs as shown, so that the stampings "clear" or fall away from the dies by gravity into a box at the rear of the press, while the scrap is removed by the operator, who then feeds another sheet into the press.

Square, Rectangular and Oval Can Manufacturing

The seams or joints on the bodies of cans are made in various ways, the two styles generally used being the "lap" seam and the "lock" seam as shown in Fig. 1; the latter, as will readily be seen, insures not only a stiffer construction, but also a more uniform joint. The lock-seam is almost universally used on round cans, while on square, rectangular or oval can bodies made automatically, the lap seam is generally used. The principal reason for this is that but a very limited number of "body-makers" have been perfected for successfully forming, bumping, locking and soldering square or odd-shaped can bodies, owing to the large number of cams and other

intricate and delicate motions and feeds to be developed for work of this character. The same statement applies to the other automatic machines required for the various operations on square and irregular-shaped cans, which operations must now be performed almost entirely by hand or only semi-automatically, this being the prime reason for the abnormal difference in the price of these and the round cans.

One of the worst features in connection with automatic can-manufacturing of today, particularly on square can work, is the fact that while a number of large builders have invented and perfected successful machines for producing can-bodies and other operations on cans, they, as well as private inventors of successful machines, have entered into agreement with a few of the largest can-manufacturers throughout the country. By this agreement the original inventors or builders, for a consideration, are prohibited from selling these machines to any but the export can-manufacturing trade. The results are obvious. Foreign-made square and other odd-shaped cans particularly are in many respects superior to those that can be produced by American competitors with the limited equipment they can purchase in this country for manufacturing their product.

De-tinning and Solder-making

The reader will undoubtedly be curious to know what is done with scrap accumulating in a can-factory. Where it is possible to do so, this scrap is cut up in "scrap shears" for convenient handling and is run through small power presses fitted with dies for cutting out roofing caps or washers, upholstery buttons, small trunk trimmings, etc. The scrap that is left is then de-tinned (by electrical and other processes) which operation consists of melting the pure tin off the original black sheet, the tin being used again as part of the solder mixture, and the de-tinned scrap sold to the foundries, which usually work it up into sash-weights or other low-grade iron products.

As previously stated, solder is one of the most expensive essentials of can-making. All the solder brushed from the cans by the "solder-savers", together with the sweepings, is carefully melted and refined and used over and over. Most of the large can-factories have their own solder-melting, rolling and cutting equipment with which they prepare, melt and mix the various solder mixtures and shapes they require. Tin and lead are used in varying proportions in solder for various grades of work. The solder is melted and then rolled or molded into ribbon, wire, triangular, flat bars or other shapes to suit the various classes of work.

Lithographed or Decorated Can Manufacturing

Lithographed or fancy colored can manufacturing is not only very interesting, but also about the most profitable work in this line of manufacture, there being about as much difference in the quality of lithographed tin work as in ordinary lithographed or printed work. Most people have the idea that lithographed or decorated cans are painted after being made up. This is not the case, except, of course, with large shipping cans, gasoline storage and other large "painted" cans, which are decorated by hand and are not only a lower grade, but also cheaper.

The sheets from which the various parts of lithographed cans and boxes are cut have the colors applied or impressed on them "in the flat" in a lithographing press, which is very similar to a large printing press, but far more costly. Tin lithographing presses will print from one to five colors at one handling, depending upon the size and design of the press used. The printing or transferring operation is performed by means of large close-grained stones, carefully smoothed off, cut to size and carved or engraved with the design to be transferred or imprinted on the tin.

For lard-pail bodies and similar large receptacles, one stone has but a single design cut in it, while stones for lithographing sheets from which are cut the covers or bodies of typewriter ribbon boxes, talcum powder boxes, etc., are engraved to produce at one handling a printed sheet such as is shown in Figs. 5 and 6. Both these illustrations show part of each sheet already cut out, to illustrate the econonomical printing and cutting of this class of work. In the sheets shown one-sixteenth inch is allowed between the successive cuts, which is the usual allowance for tin and other light stamping work. This amount should be increased in proportion to the thickness of the metal to be cut, so as to leave the scrap or uncut portion of the sheet sufficiently stiff to prevent it being drawn down into and plugging up the dies on the next cut. After being printed, the sheets are placed on large portable steel racks with wire shelves, one sheet being placed on each shelf. The rack is then placed in a gas-heated baking oven in which the colors are thoroughly baked onto the metal sheet.

The cutting and forming of lithographed work is performed in the same manner, and with tools of the same construction throughout, as are used on plain tin or other metal. The dies and other forming tools, however, must be made with a little greater clearance to allow for the thickness of the coating of paint and must be finished harder and smoother and with a greater degree of accuracy, so as not to scratch or mar the printed design.

This branch of can-manufacturing has been perfected to such an extent as to almost permit of calling it an art. Equally as much depends upon the design and the transferring or lithographing, as upon the actual cutting and forming of the various lithographed parts of cans, advertising signs, trays, plates, etc. In fact, on the plate-rails of many homes today are to be found lithographed tin or black-iron plates, which are almost impossible to distinguish from the expensive hand-painted china plates, although there is a difference in the manufacturing and selling prices of the two of from five hundred to fifteen hundred per cent. There is an even greater field for the development of automatic machinery for lithographed work than for plain tin-can work, as forming and soldering operations particularly are extremely difficult to perform with automatic machines on lithographed metal work, with any degree of assurance that the work, when finished, will not be scratched or marred.

* * *

ANNEALING SHEET STEEL

By ORONO

The reason that steel has not replaced brass in small factories to a greater extent in making shells and similar shapes, where it is necessary to anneal the material between the different operations, is doubtless due to the fact that it is much easier to handle brass than steel while annealing. To anneal steel successfully it is customary to place the articles to be annealed in a sealed pot, where they are heated to the proper temperature, and then allowed to cool, without removing them from the pot. It is necessary to keep the air from the steel while heating, to prevent an oxide being formed on the surface, which if allowed to form will increase the difficulty of finishing, where a smooth bright surface is desired. When there is not sufficient annealing to be done to make it profitable to employ this method, the use of brass is resorted to, as the same trouble is not encountered with the surface of the brass oxidizing when exposed to the air.

In attempting to cup small steel shells 3/8 inch in diameter and 5/16 inch high, made from 0.020 inch sheet steel, it was necessary to anneal them. The following method was adopted and proved satisfactory: After the drawing operation, the shells were tumbled in a barrel until they were bright and then brass plated. They were then placed in an open pot, heated to a dull red heat, and allowed to cool. The brass plate on the surface of the steel protects it from oxidization; this is accomplished in a manner similar to sealing the pieces in a pot when annealing. In shops equipped with a plating outfit, this makes a simple method of treating small steel work, as it can be tumbled and plated at slight cost.

* * *

A reinforced concrete boat provided with a gasoline motor has recently been built in Holland. The boat is nearly 15 feet long, and the remarkable fact about it is that the walls are only 0.52 inch thick. These walls, however, are strengthened by ribs. The concrete was given several coats of waterproofing compound. It has been in a number of collisions, but has not been disabled or made leaky.

REPAIRING LATHES AND MILLING MACHINES

By EDWARD K. HAMMOND*

Machine tools are frequently exposed to excessive wear owing to the conditions under which they are operated by unskilled workmen and, unless prompt steps are taken to adjust the machine and take up this wear, accurate work cannot be obtained and the tool is bound to suffer a rapid deterioration.

The average machinist is not familiar with the methods which are used to adjust and repair the machine tools which he uses; work of this kind is of a highly specialized character and many a machine has been pronounced worthless and has been discarded when, as a matter of fact, it could have been put into condition to fit it for a number of additional years of service if the machinists in the shop had understood the methods which would have enabled them to handle the work of putting it into proper adjustment. However, there is nothing difficult about these methods and any good mechanic can do the work if he is familiar with the method of procedure, which it is the purpose of this article to explain.

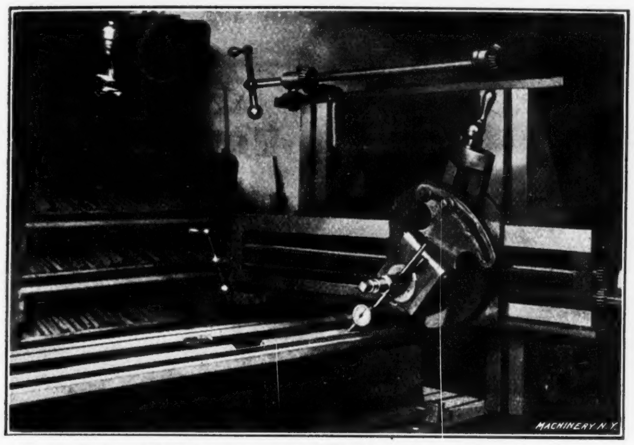


Fig. 1. Determining the Accuracy of Finish of Lathe Ways by Means of a Test Indicator

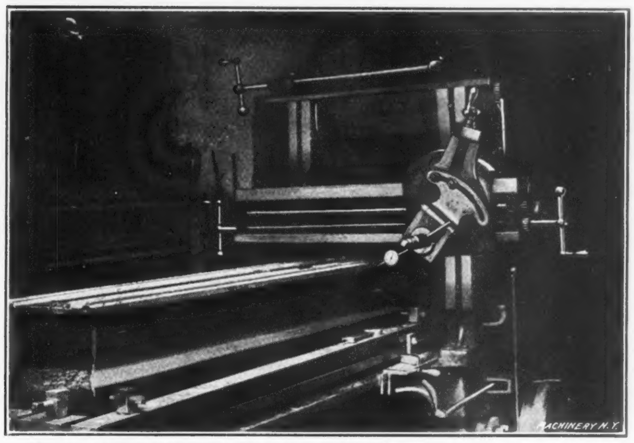


Fig 2. Testing Parallelism of the Outer Edge and Ways of a Lathe with the Test Indicator

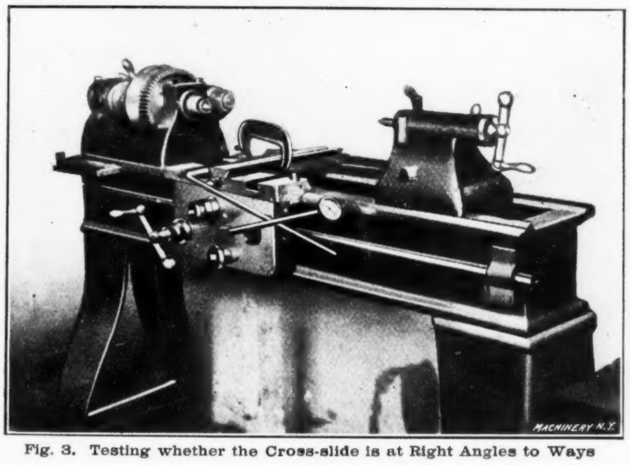


Fig. 3. Testing whether the Cross-slide is at Right Angles to Ways

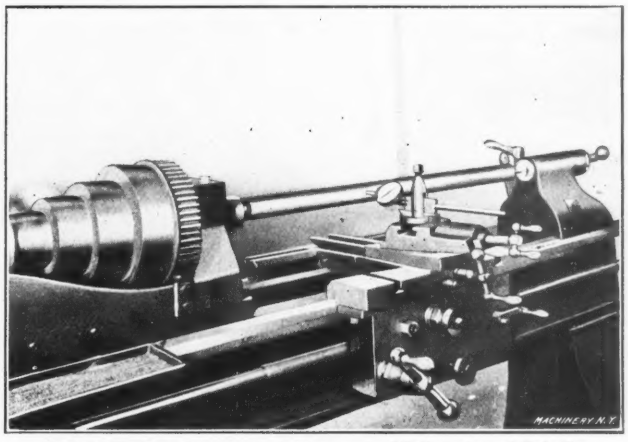


Fig. 4. Testing Accuracy or Alignment of Tailstock and Spindle

How to Adjust a Badly Worn Lathe

In the factory of the Lodge & Shipley Machine Tool Co., Cincinnati, each foreman is required to stay after the workmen have gone home on Saturday afternoons and determine the accuracy of the lathes which are used in his department. By this system, each machine is inspected once a month. The Lodge & Shipley Machine Tool Co. is one of the best known builders of high-grade lathes in America and with its intimate knowledge of the construction and operation of these machines, it is in a position to fully realize the importance of having each lathe which is used in its factory kept in proper adjustment.

There are many machine shop proprietors who would do well to follow this system, for a machine which is worked steadily, often under the most severe operating conditions, cannot be expected to give satisfaction when it does not receive constant attention, and in addition to the sacrifice of accuracy in the product, the tool is bound to experience a rapid deterioration in value.

In adjusting a lathe which has been badly worn, the first step is to dismantle the machine and refinish the ways. This is done by scraping or, if the machine is very badly worn, by first planing and then scraping the ways to a final finish. In cases where the machine has been badly worn and it is necessary to have recourse to planing, care must be taken to remove as little metal as possible, only that amount being taken off which is absolutely necessary to remedy the inaccuracy which exists in the ways. The outer edges of the bed are then planed to bring them in alignment with the ways.

A Brown & Sharpe dial test indicator is used to determine the accuracy of the refinished ways and also the parallelism of the ways with the outer edge of the bed. Most machinists are familiar with the dial test indicator, which consists of a graduated dial over which a needle is free to rotate. This needle is actuated by a small plunger which is held in contact with the finished surface of the lathe bed by means of a spring. The dial test indicator is mounted in the tool-post of the planer as shown in Figs. 1 and 2 and as it passes back and forth over the work, any inaccuracy in the finish of the surface causes the plunger to rise or fall. This movement of the plunger causes a corresponding movement of the needle of the dial test indicator. The dial of the instrument is graduated to read to 0.001 inch, and as the needle rotates over the dial, it shows any inaccuracy which exists in the refinished ways of the lathe bed in thousandths of an inch. The accuracy of the finish of the ways is determined as shown in Fig. 1. The dial test indicator is then brought into contact with the outer edge of the lathe bed and traversed back and forth to determine whether or not this edge is exactly parallel with the ways, as illustrated in Fig. 2.

After the bed has been accurately finished, the lathe is reassembled. The next step is then to determine whether the cross-slide is set exactly at right angles with the ways. In making this test, the Brown & Sharpe dial test indicator is mounted on a bar which is bent at right angles, as shown in Fig. 3. The compound rest is then taken off the lathe and

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the bar carrying the dial test indicator is clamped in the V-bearing of the cross-slide, as shown in the illustration, in such a way that the plunger comes up against the outer edge of the lathe bed which was refinished in the previous operation, as described. A C-clamp is used for this purpose which has a notch ground in it to fit over the bar carrying the indicator, in such a way that the bearing for the bar is formed between this notch and the vee of the cross-slide. The reading of the dial test indicator is now noted and the bar carrying it is then swung over so that the instrument comes up against the edge of the lathe bed on the opposite side of the carriage. The reading of the dial test indicator is again noted. If this reading is the same as that which was obtained on the opposite side of the lathe carriage, it shows that the cross-slide is at exactly right angles with the ways. Any difference in the two readings shows an inaccuracy in the setting of the cross-slide, and this inaccuracy must be removed

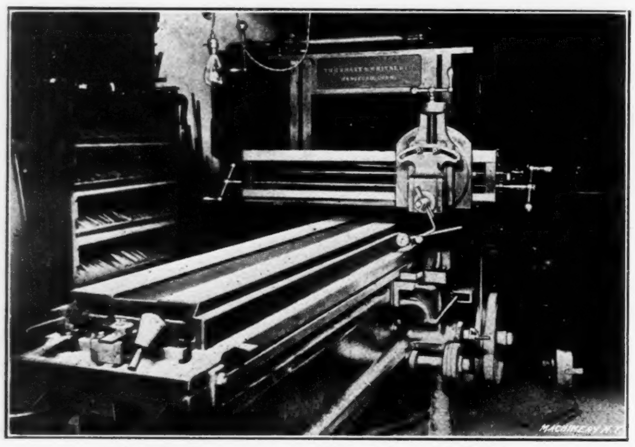


Fig. 5. Testing Slide of Milling Machine Table

by scraping the V-bearings until the test can be made with satisfactory results. The compound rest is then replaced on the machine. No difficulty will be experienced in maintaining the crosswise location of the test-bar in the V's during the half revolution, if proper precaution is taken.

If the spindle bearings show any signs of wear, they are scraped to a perfect fit. The next step is to determine whether or not the spindle is in proper alignment with the ways. In making this test, the faceplate and live center are removed from the spindle and a test-bar, which has been turned to a correct taper at the end, is placed in the spindle; with the exception of the taper end, this test-bar has been turned to an absolutely true cylinder. With the test-bar in position in the spindle, the dial test indicator is mounted in the tool-post of

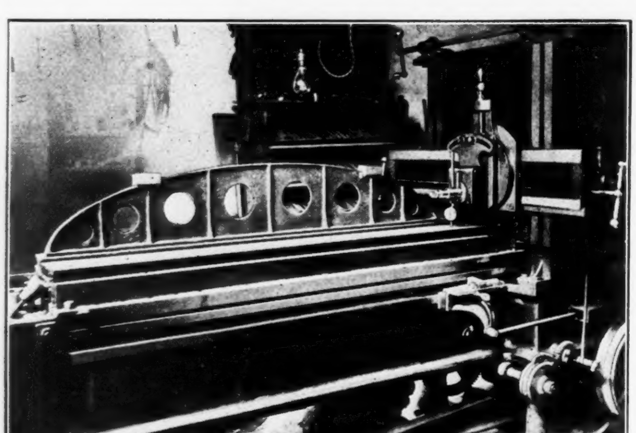


Fig. 6. Testing the Ways of a Milling Machine Table

the lathe and brought up against the test-bar, first at the top and then at the side. While in both of these positions, the lathe carriage is traversed back and forth so that the dial test indicator moves over the entire length of the bar. If the reading of the dial test indicator remains constant while being traversed at both the top and side of the test-bar, it shows that the spindle is in proper alignment with the ways. Any inaccuracy which is revealed by this test must be removed by scraping the V-bearings of the headstock. The test is then repeated until it is found that the proper adjustment has been made. The live center and faceplate are then replaced on the machine.

The next step is to scrape the V-bearings of the tailstock so that the tailstock lines up properly with the spindle. The accuracy of this alignment is determined by placing a test-bar between the centers of the lathe. The dial test indicator, which is still mounted in the tool-post of the lathe, is brought

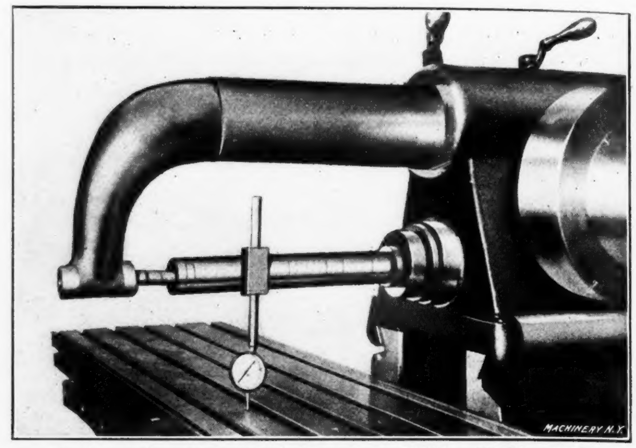


Fig. 7. Testing Longitudinal Alignment of Milling Machine Table

up first against the top and then the side of this test-bar, and the carriage is traversed so that the dial test indicator moves across the entire length of the test-bar while in both of the positions. If the dial test indicator gives a constant reading during its entire traverse at both the side and the top of the test-bar, it shows that the tailstock and the spindle are in proper alignment. However, if any inaccuracy is exposed by this test, the V-bearings are scraped until the proper adjustment has been secured, as shown by a constant reading of the dial test indicator when traversed over both the top and the side of the test-bar, as previously described.

A lathe which has been properly adjusted by this method

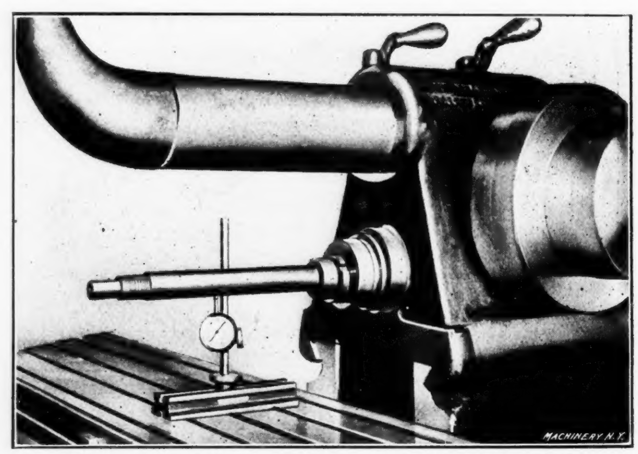


Fig. 8. Testing Crosswise Adjustment of Milling Machine Table

will be capable of producing perfectly accurate work. In operation, however, there is always a chance of disturbing the adjustment of the machine through unavoidable wear or excessive strains. To guard against this source of error, the tests which have been described above should be applied to every lathe in the shop at intervals of about a month. Where this precaution is taken, there will not be a possibility of a machine becoming badly worn, and all the adjustment which will be found necessary can easily be made by doing a little scraping. Such a course of action will be found the means of improving the accuracy of the product, and the time spent in tests and adjustment will be more than repaid in this way.

Methods used in Adjusting a Milling Machine

It is not generally known how easily a heavy casting can be drawn permanently out of shape. The popular conception is that such a casting is absolutely rigid and that it will break rather than bend out of shape; such, however, is not the case. Under the heavy loads which such castings are often

called upon to carry, a very appreciable change in shape takes place, and if they are kept in this strained condition for an extended period of time, the deformation of shape becomes permanent.

Milling machine tables are often damaged in this way. Through the inexperience of the operators who are often given charge of a miller, the work is sometimes clamped to the table much more tightly than is necessary; in such cases, the table is drawn out of shape and if it is allowed to stand in this condition for a considerable length of time, it is almost sure to be sprung permanently out of shape. If a table has been damaged in this way, the inaccuracy should be remedied by planing and scraping to a final finish. In very bad cases of this kind, however, where it would make the table too light if all of the error were removed by planing, the table should be taken off the machine and clamped to the table of a heavy planer in such a way that it will be drawn back into shape. After being allowed to stand in this way for several hours, it will be found that most of the error has been removed. The final finish is then obtained by planing and scraping, as previously described.

While the table is still mounted on the planer, it should be lined up with the dial test indicator, as shown in Figs. 5 and 6. The sides of the table are then replaned, where necessary, and they are then lined up with the bearings, as shown in the illustration.

The accuracy which has been obtained on the face of the table is determined by means of a Brown & Sharpe straightedge. Most machinists are familiar with this tool, which consists of a plate of metal finished on one side to a perfectly flat surface, with a rib cast on the back to hold it in shape; the rib also serves as a convenient handle in using the straightedge. The finished surface of the straightedge is used as a standard of reference in determining the accuracy of the finish which has been obtained on the table of the miller by the well-known means of coating it with red lead. The test is repeated, together with the scraping, until an accurate finish has been obtained. The saddle of the machine is then scraped to fit the table bearings.

The table is then remounted on the milling machine and the next step is to determine whether the spindle is in proper alignment with the table of the machine. This is done by mounting the bar which carries the dial test indicator between collars on the arbor of the machine, as shown in Fig. 7. The plunger of the dial test indicator is then brought into contact with the table and the latter is traversed through its entire range; a proper alignment between the spindle and the table will be shown by a constant reading of the dial test indicator for all positions of the table. Any inaccuracy which is exposed by this test must be removed by further scraping of the table at those points where the indicator shows that it is high.

The same test may be made by mounting the dial test indicator on the base and post, as shown in Fig. 8. A test-bar with the proper taper at the end is then placed in the spindle of the miller. The dial test indicator is then brought up against the test-bar at both the top and the side and the table traversed across; a constant reading of the dial test indicator shows the spindle to be in proper alignment.

While these tests and adjusting operations are not generally used by machinists, they will be readily understood from the preceding description and little difficulty will be experienced in doing the work. Like those which were described for use in adjusting a lathe, these tests may be used to advantage at regular intervals for determining the accuracy of the millers in the shop, and by taking the necessary steps to prevent a machine from getting badly out of adjustment, the wear and consequent depreciation in value of the equipment will be reduced to a minimum. This system will also prove valuable in improving the accuracy of the work which is turned out in the shop. The use of these methods has been the means of preventing many a good machine tool from being discarded as worthless, merely because it was a little worn and consequently somewhat inaccurate.

* * *

A two-speed planer and a one-speed man makes a misfit. A two-speed man and a one-speed planer makes another.

MACHINE SHOP PRACTICE—1

THE MAKING OF REAMERS*

By J. C. CUSTER†

The subject of reamers has so often been discussed in the trade journals, and so many have contributed towards a settlement of the question of how a reamer ought to be made, that by this time nearly everyone should be able to make a good reamer. It therefore seems almost useless to add anything further, and the writer should not have attempted to say anything on the matter, had not, in an editorial note accompanying a brief remark on the milling of reamers in the August number of MACHINERY, the views of others been solicited. An additional reason is that the rank and file in the machine shop is constantly augmented by new recruits in the trade who know nothing about the making of reamers, but have to go through a training similar to that of their seniors before them, in order to acquire the skill and the knowledge that they are supposed to have at the end of their term of apprenticeship.

The writer wishes it to be understood that he does not claim to know anything about reamers that is not known by hundreds of others, and the following pages are not written for the benefit of those who know, but solely for the benefit of the younger mechanic who does not know, but is willing to learn. With this in view, the writer shall give an account of some of his practical experience, and of his methods of making reamers that have given satisfaction. It is not claimed that the methods described are the only ones worth following; all that is claimed for these methods is that, if carefully and conscientiously followed, one will be able "to make good" in most shops. For the purpose of greater comprehensiveness, we will consider the entire process of making a reamer.

Kinds or Types of Reamers

There are various types of reamers, all of which are designated by appropriate names such as: straight, spiral, taper, adjustable, hand, machine, etc., reamers. These names indicate what purpose the reamers are expected to serve or how they are to be used, *e. g.*, we would expect an adjustable reamer to be made so that the size could be regulated to compensate for wear, or for the purpose of reaming a hole either "full" or "scant." If a reamer were to be used in a machine such as a drill press, then it would have a shank suitable for that machine, but if to be used by hand, then the shank would be made accordingly *i. e.*, supplied with a square for the wrench; this latter style is often called a "standard reamer."

The making of good reamers in a small shop, or in a shop poorly equipped for such work is expensive, and a good reamer can sometimes be bought for less than it would cost to make one.

Turning

Assume that it is required to turn the blank of a one-inch reamer, 12 inches over-all in length, to be used in a drill press fitted with taper sockets. The first work upon the stock is the centering, which may be done "in any old way," but if service and general appearance of the reamer are to count, then we should have a small center in the shank-end (a large center weakens the tang) and a large one at the reamer-end, so that if it becomes necessary, during the life of the reamer, to grind a small amount off the end, we may do so and yet retain the center for future grinding on the cutting edges. This feature is particularly desirable on taper reamers that have to ream a given size at the bottom of a hole. Through wear and repeated sharpening, the reamer will become too small at the end, so that it must be shortened or replaced by a new one. The sharpening referred to is machine-grinding; for stoning by hand we need no centers. Stoning, however, is bad practice, as one is apt to stone the taper out of true.

*The following articles on this and kindred subjects have previously been published in MACHINERY: "Irregular Spacing of the Cutting Edges of Reamers," May, 1910; "Irregular Spacing for Reamers," May, 1910; "Errors in Grinding Tapered Reamers and Milling Cutters," December, 1909; "Milling Flutes in Reamers with Irregular Widths and Depths," December, 1909; "An Adjustable Reamer," December, 1909; "Squares on the Ends of Taps and Reamers," April, 1909; "Setting-angles for Milling Angular Cutters and Taper Reamers," November, 1908, engineering edition; "Grinding Reamers," November, 1907; "Reamers," August, September, October, November, and December, 1907; "Adjustable Reamers and Taps with Inserted Blades," July, 1907; "New Method of Milling the Flutes in Reamers," February, 1907; "Reamer Clearances," June, 1904.

†Address: 819 Broad St., Bridgeport, Conn.

After centering, ascertain what size shank the drill that is to be used in connection with the one-inch reamer is fitted with, and then turn the same size shank on the reamer; the reason for this is plain. If the reamer is to be ground all over, turn the blank about 1/64 inch over-size. The shank-end of the blank should be faced off to an angle corresponding with the drift used in the drill press, usually about 8 or 9 degrees. The corner at the reamer-end is chamfered, the chamfered surface measuring about 3/32 inch in width and being at an angle of about 45 degrees. This angle is of little importance as far as cutting qualities are concerned, but it should be uniform in order to simplify future grinding of the ends of the teeth. The reamer proper should have a length of about 2½ inches. The straight part of the shank (the "neck" between the reamer portion and the taper shank) should be smaller in diameter than the reamer. The smaller we turn this part, the lighter will be the tool, but the bigger we leave it, the more suitable will be the stock for something else when the reamer is worn out. In regard to the taper part of the shank, refer to some table or hand-book giving dimensions of standard taper shanks;* these shanks are usually fitted to a "taper-shank gage" found in nearly every shop that makes its own small tools.

Taper Reamers

We need say but little about the turning of the blank for the ordinary taper reamer, but it should be noted that a taper reamer intended for roughing differs but slightly from one intended for finishing. Sometimes it is made in "steps." In this case, first turn the blank to the proper taper; then cut a series of grooves about ½ inch apart, 3/32 inch deep and about 3/32 inch wide. These dimensions may have to be modified according to the taper and the size of the reamer. Now set the tailstock as for straight work, and turn each section or step straight. In this way a taper reamer that does not have a gradual increase in diameter, but which increases by small steps, is obtained. The teeth cut only at the ends of each step. Another way is to make the roughing reamer like a finishing reamer except that the teeth are "nicked." This nicking is done in the lathe by turning a groove having about 1/2 inch lead, 1/16 inch deep, using an oil-grooving tool about 1/16 inch wide. It might be presumed that this groove should be cut with a left-hand spiral to prevent the reamer from feeding into the work too fast, but for good practical reasons, however, this groove should be cut with a right-hand spiral (on a right-hand reamer), because this gives the teeth a positive rake at the nicks along the flute, while a left-hand spiral gives a negative rake which causes trouble after the reamer has been in use for some time.

A very good roughing reamer may be made by cutting a right-hand spiral groove having about ½ inch lead, and then turning the lands between the convolutions of the groove straight, so that the blank is "stepped" spirally. This is done (leaving the lathe set as for taper turning) with a square or broad-nosed tool, using the same feed as used for cutting the groove—½ inch per revolution. The edge of the tool must be set parallel with the axis of the work. The "stepped" style of reamer costs somewhat more to make, because each step must be backed off individually, but the extra labor is well spent. This reamer may, however, be relieved towards the back when turning the blank by setting the broad-nosed tool so as to produce a back relief, instead of setting it exactly parallel with the axis. This would eliminate the necessity of backing off in the grinder, but the backed-off reamer gives better satisfaction.

It does not seem necessary to go into further details in regard to the turning of reamers. When turning the bodies of adjustable reamers with inserted blades, it should be remembered, however, that the body should be about ⅛ inch smaller in diameter than the required size of the finished reamer, which allows each blade to project 1/16 inch from the body when the reamer is adjusted to size. The body of adjustable reamers is made of soft steel or cast iron.

*See MACHINERY'S Data Sheet Series No. 4, "Reamers, Sockets, Drills and Milling Cutters," or MACHINERY'S Reference Series No. 35, "Tables and Formulas for Shop and Drafting-room."

Milling

The milling or fluting of right-hand reamers (left-hand reamers are never used except for special screw machine operations when it is desirable to run the spindle backwards) should be done in a milling machine having the headstock or dividing-head to the left of the operator—like a lathe—and the work should be indexed around towards the operator. Some of the so-called "formed" reamer fluting cutters produce a weaker tooth than the ordinary angular cutter, as may be seen by a comparison of Figs. 1 and 2. If a straight-fluted reamer is cut with an ordinary angular cutter, having a vertical side, the cutter must be in good condition or a ragged tooth will result. The saddle should be set slightly past zero to prevent "back-cut."

A cutter combining several good features for the milling of straight-fluted reamers is shown in Fig. 2. This cutter, by reason of the angular side, will cut a good tooth-face, and

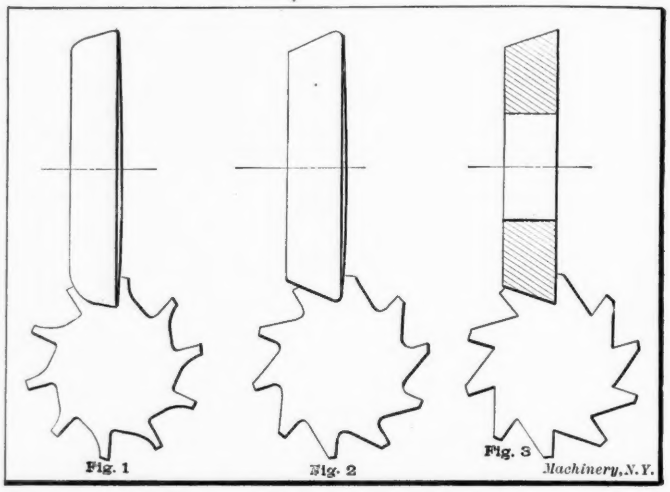


Fig. 1. Illustration showing Reamer Tooth produced by a "Formed" Reamer Cutter

Fig. 2. Tooth produced by Cutter having an Angle of 2 1-2 Degrees on Face and Round Corners

Fig. 3. Tooth produced by Cutter with Straight Face and Sharp Corners

produces a strong tooth as shown. Another advantage is that it can be set radial or slightly "ahead of center" simply by sighting past the side of the cutter while we bring the work into the line of sight. A scratched line on the top of the tailstock over the axis of the centers facilitates such setting. Reamers for steel and cast iron have the face of the teeth either radial or slightly ahead of the center, but reamers for brass or bronze give better satisfaction if the face of the tooth makes an angle of 5 or 6 degrees with the radial line, being that amount ahead of the center.

A strong tooth and flutes of sufficient depth to give room for chips are the essential features of a reamer; both of these depend on the number of teeth and the shape of the fluting cutter. In the smaller sizes there is no choice in regard to the number of teeth, as a fluted reamer with less than six teeth does not work well, and it surely cannot be made with more. Straight reamers should have an even number of teeth so that the size of the reamer can be easily measured.

Formed cutters for fluting reamers have usually stamped upon them the size of reamer and the number of teeth for which they are adapted, but experience has taught the writer that the number of teeth indicated is in many cases too fine for a large class of work in ordinary machine-shop practice. Among the equipment for milling reamers at the disposal of the writer, is a formed cutter intended for ten teeth in reamers of from 1 1/16 to 1 1/2 inch diameters; this is a suitable number of teeth for the 1⅜ and the 1½ inch size, but it seems too fine for a 1 1/16 inch reamer. "Many hands make light work" must not be understood to mean that many teeth make light and easy reaming. Some of the readers may be surprised when they are told that nearly every day the writer sees reamers in operation that have but two teeth reaming holes up to eight inches in diameter, and doing good work quickly. An illustrated description of this reamer is contained in the Bullard Machine Tool Co.'s (Bridgeport, Conn.) catalogue.

Reamers are usually fluted in one operation, but if we want

to cut a well proportioned eight-tooth reamer, 1⅛ inch in diameter, with a cutter designed for a ten-tooth reamer of the same size, then a second operation becomes necessary. In the first place, we cut the face of the teeth to the proper depth (all around), and in the second, we reduce the lands to the desired width.

Angle of Fluting Cutter

We will now consider the relation between the angle of the flute and that of the tooth of a solid reamer. For the sake of simplicity consider a reamer that has been fluted with an ordinary angular cutter, as shown in Fig. 3. If we were to cut teeth on a straight piece of work, such as a hack-saw blade, we would find that tooth and space would be of the same angle, *i. e.*, if we used a 50-degree cutter, the space would be 50 degrees and the tooth, likewise, 50 degrees. The same principle is demonstrated when cutting a screw in a lathe, using a 60-degree tool; we get a 60-degree thread. But if we want to cut teeth on the surface of a cylinder, as, for instance, in a reamer, the face of the tooth being radial and parallel with a plane through the axis of the work, then the proposition is entirely different, and we no longer have tooth and flute of the same angle. There will, instead, be a difference of 360 degrees in the aggregate. Suppose we want to flute a reamer the tooth of which should measure 30 degrees. (From 30 to 35 degrees is a suitable angle for reamer teeth.) First we ascertain what number of teeth will be the most suitable. This we will assume to be six. Then, since the sum of the angles of the six flutes or spaces is 360 degrees greater than the sum of the angles of the six teeth, each flute will be $360 \div 6 = 60$ degrees greater than the adjacent tooth, and as we want to cut a tooth of 30 degrees we must use a cutter of $30 + 60 = 90$ degrees. This, expressed in a formula, would be:

A = angle of space, or of cutter to be used,
B = number of teeth in reamer,
C = desired angle of tooth.

Then,

$$A = \frac{360}{B} + C$$

Substituting for the symbols the actual figures for a one-inch reamer, 8 teeth, 35-degree tooth, we have:

$$\frac{360}{8} + 35 = 80$$ degree cutter to be used for fluting.

It was just stated that an angle of from 30 to 35 degrees is a suitable angle for reamer teeth; this should not be understood as applying at all times and for all sizes. If we were to cut a ¾-inch reamer, 6 teeth 30 degree tooth, we would, according to the formula, use a 90-degree cutter, but if we should use this same cutter for a ½-inch reamer, the flutes would be rather shallow, and they would be still more so in the ⅜-inch size.. Cutters of 87½- and 85-degree angles are better adapted for these sizes, which would give a tooth of 27½ and 25 degrees, respectively. Very often a 40-degree tooth is the one most suitable for the larger sizes. This does not mean, however, that we can say off-hand what the tooth-angle shall be, and then proceed to cut any number of teeth on a certain size reamer, for the number of teeth has a great deal to do with the angle of the teeth. In addition, the general appearance of the flute and the tooth depends largely on the rounded corners of the cutter used for fluting, as may be seen by a comparison of Figs. 2 and 3.

Taper Reamers

What has been said about solid chucking reamers in regard to teeth, holds good, largely, for taper reamers, except that we may cut an odd number of teeth in them if we have a shell-gage to which to grind them. It is claimed that reamers with an odd number of teeth chatter less than those with an even number; this the writer can neither confirm nor deny, since they seem to work alike with him. Stepped taper roughing reamers are generally made with four flutes, and if so made, the tooth should be similar to the tooth in a four-lipped drill.

Spiral Reamers

A right-hand reamer used in an automatic screw machine should have the teeth cut on a right-hand spiral, as this form is better adapted to allow the chips to pass out freely. For deep reaming, an oil-reamer is sometimes used for getting rid of the chips. Such a reamer has a hole drilled through the center and is used like an oil-drill. Left-hand spirals on right-hand reamers are more apt to force the chips ahead, which is a good feature when reaming holes passing clear through, in a vertical machine such as a drill press.

* * *

RECENT TESTS OF MACHINERY BRAKE LININGS

Prof. C. L. Norton, of the Massachusetts Institute of Technology, recently made some tests of materials used as machinery brake linings, which show that asbestos is a superior material for this important part of certain classes of machinery. The manner in which these tests were made was quite simple, yet the results obtained were accurate. The different materials used in brake bands were applied one by one to the surface of a steel drum which was revolving under approximately the identical speed conditions of the ordinary machinery brake drum. The normal contact pressure and the tractive force were carefully measured, and the arc of contact and the pressure per unit of area were varied over wide limits. Each specimen was tested when new and after several days' running. In the case of the asbestos lining, the coefficient of friction did not vary sensibly with the pressure per unit of area or the length of the arc of contact. The final results showed that the two specimens of the asbestos lining, called respectively "J. M. Non-Burn A" and "C", showed a coefficient of friction of 0.37. The relative value of asbestos linings to other linings may be found by comparing this figure with the figures given as follows:

	Coefficient in Motion		
Material	Dry	Wet	Oily
Asbestos to metal......	0.37	....	0.20 to 0.25
Metals on metal.......	0.15 to 0.24	0.31	0.20 to 0.06
Wood on metal........	0.20 to 0.62	0.24	0.20 to 0.06

Oil was applied to these asbestos brake linings without much effect. While it was possible by means of a forced test of oil between the asbestos lining and the metal drum to bring the coefficient of friction down as low as 0.20, it was found that a good value for the coefficient of friction of the asbestos brake linings after they had been soaked in oil or exposed to splashing from oil was from 0.20 to 0.25. Values as high as 0.30 are not infrequent for an oily lining used under high pressure. Even when the asbestos brake lining was thoroughly saturated with oil the coefficient of friction, although it went down materially upon the first application of the brake, was not afterward greatly affected. It is to be noted that under the heat of the friction when the brake was again applied to the drum, the oil was quickly volatilized and the coefficient of friction was rapidly raised toward the maximum when dry. An asbestos brake block tested under similar conditions proved to have a more variable coefficient, depending upon the nature of its contact surface. The limits observed were 0.32 and 0.39. While the tests were indeterminate as to wear, they indicated that the material is very durable. An asbestos lining absorbing 15 horsepower for ten hours lost only a few grains in weight.

* * *

In a recent issue of the *Practical Engineer*, a brief description is given of the difficulties incident to transporting two big castings intended for two large British dreadnaughts. These castings, each weighing about forty tons, were to be conveyed from Sheffield to the docks at Liverpool. They each measured 12 feet, 4 inches in width, when loaded on a car, with a maximum height above the rail level of 10 feet, 7½ inches. This would be difficult enough to handle with American clearance limits, but with the 9-foot loading limit on the English railways, still greater difficulties were encountered. The transportation was satisfactorily accomplished by stopping all traffic on opposite lines of rail between Sheffield and Liverpool while the castings were being moved.

* * *

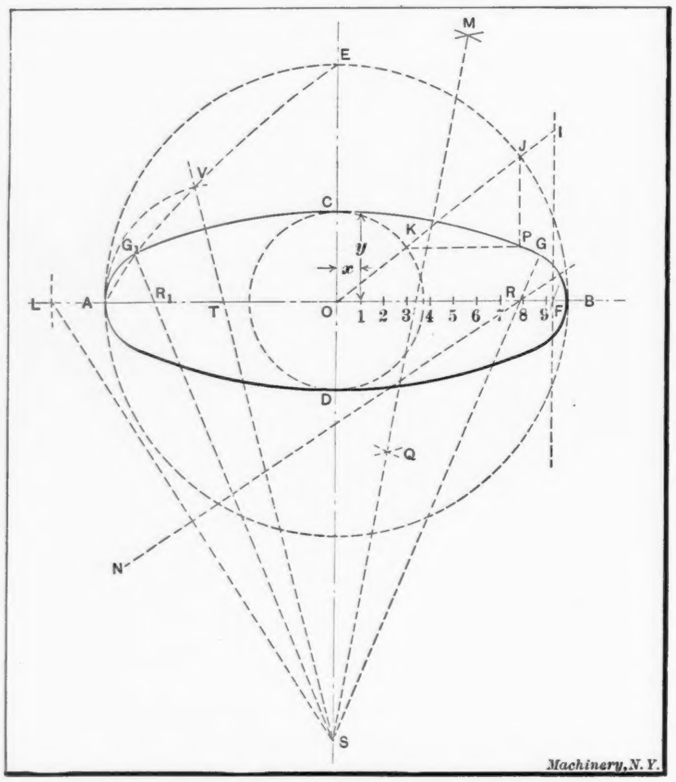
A dirty machine may be a sign of such busy times that the operator has no leisure to clean it up, but it is more likely to be a sign of slovenliness.

CONSTRUCTING AN APPROXIMATE ELLIPSE WITH TWO RADII

By J. J. CLARK*

In MACHINERY for March, 1911, engineering edition, Mr. H. A. S. Howarth describes a method for drawing an approximate ellipse with two radii and four centers. The method is chiefly defective because the second arc does not pass through the end of the major axis. As it is a very easy matter to locate geometrically the center for the second arc so that it will pass through the point B and be tangent to the first arc, one wonders why Mr. Howarth did not give the construction instead of devoting more than one-half of his article to discussing errors which ought not to have occurred. The writer has devised the following method of constructing an ellipse with two radii, which he believes to be as simple as that of Mr. Howarth's, and thinks that the resulting curve has a better appearance for flat ellipses; *i. e.*, when the ratio of the axes is 3:1 or greater. In so far as was practical the accompanying illustration has been lettered in the same manner as Figs. 1 and 2 of Mr. Howarth's article.

Construction.—Draw AB and ES at right angles to each other, and, with the point of intersection O as a center,



Method of Constructing an Approximate Ellipse with Two Radii

describe two circles with the semi-axes OA and OC as radii. Locate a focus F by taking C as a center, OA as a radius, and striking a short arc intersecting OB at F. Through F draw a perpendicular to AB and lay off FI equal to CD, equal to the minor axis. Draw OI, cutting the large circle at J and the small circle at K. Draw JP and KP, perpendicular and parallel respectively to AB; they intersect at P, a point on the true ellipse. With P and C as centers and any convenient radius greater than one-half CP, describe short arcs intersecting at M and Q. Draw MQ intersecting ES at S, the center for the arc passing through C. Describe the arc G_1CG, extending it beyond P. On AB lay off BL equal to CS, equal to GS, and bisect LS by a perpendicular NR, intersecting AB at R. Draw SR intersecting arc CPG at G. Then R is the center for the second arc, G is the point of tangency for the two arcs, and RG, which is equal to RB, is the radius.

For very flat ellipses, it may be inconvenient to lay off BL equal to CS; if such is the case the center R and point of tangency may be located as follows, referring to the left-hand half of the figure: With a point T, about midway between O and A, as a center and TA as a radius, describe arc AV; draw ST, intersecting this arc at V. Pass an arc of a circle through the three points A, V, and E, by the usual geometric construction; this arc intersects the arc G_1CG at G_1. Draw SG_1, intersecting AB at R_1. Then R_1 is the center for the second arc, G_1 is the point of tangency of the two arcs, and R_1G_1, which is equal to R_1A, is the radius.

It may here be stated that in the case of flat ellipses it is not possible to obtain a very close approach to the true curve with only two radii. The curve so obtained will either be too flat or else it will be too round at the ends. The writer

TABLE I. COMPARISON OF THE TWO METHODS WITH SEMI-AXES 10 AND 2

Semi-axes 10 and 2	True Ellipse	Approximate Ellipse (Howarth)	Approximate Ellipse (Clark)	Semi-axes 10 and 2	True Ellipse	Approximate Ellipse (Howarth)	Approximate Ellipse (Clark)
x	y	y	y	x	y	y	y
1	1.990	1.985	1.986	9	0.827	0.772	0.839
2	1.960	1.940	1.944	9.2	0.784	0.716	0.786
3	1.910	1.867	1.873	9.4	0.682	0.658	0.732
4	1.840	1.761	1.774	9.6	0.560	0.596	0.677
5	1.749	1.626	1.646	9.7	0.509	0.544	0 619
6	1.637	1.460	1.489	9.8	0.439	0.466	0.519
7	1.458	1.263	1.302	9.9	0.326	0.345	0.380
8	1.190	1.034	1.086	10	0	0	0

believes that a flat curve drawn as described has a better appearance than the curve described by Mr. Howarth. Table I was calculated for semi-axes of 10 and 2. The first column contains distances from O measured along OB. The second, third, and fourth columns contain ordinates for the corresponding distances in the first column. As it was not worth while to use Mr. Howarth's construction for the second arc, it has been assumed that the center R was found by one of the methods previously described.

Calling Mr. Howarth's curve as thus modified No. 2 and the curve in the fourth column of Table I, No. 3, that of the true ellipse in the second column being No. 1, it will be noted that the arc CG of No. 3 approaches the same arc of No. 1 more closely than the corresponding arc of No. 2; but the arc GB of No. 2 approaches No. 1 more closely than No. 3.

When the ratio of the axes is less than 3:1, Mr. Howarth's construction (when the center R is found as previously described) is much to be preferred. As a general method for drawing an approximate ellipse with only two radii, it is the best method that the writer has seen. To gratify his curiosity, the writer calculated Table II for a true and an approximate ellipse with semi-axes of 10 and 5. The approximate ellipse

TABLE II. TRUE AND APPROXIMATE ELLIPSES WITH SEMI-AXES 10 AND 5

Semi-axes 10 and 5	True Ellipse	Approx. Ellipse	Semi-axes 10 and 5	True Ellipse	Approx. Ellipse	Semi-axes 10 and 5	True Ellipse	Approx. Ellipse
x	y	y	x	y	y	x	y	y
1	4.975	4.979	6	4	3.852	9.4	1.706	1.8
2	4.899	4.876	7	3.571	3.415	9.6	1.4	1.497
3	4.770	4.721	8	3	2.892	9.7	1.216	1.308
4	4.583	4.5	9	2.179	2.449	9.8	0.995	1.077
5	4.330	4.212	9.2	1.960	2.040	9.9	0.705	0.768

is constructed by Mr. Howarth's method, as modified. On the whole it will be noted that the deviation from the true ellipse is greater than in the preceding case, when the axes were 10 and 2.

* * *

A large manufacturer of air-cooled stationary gas engines machines the cylinders on Gisholt turret lathes. The bore is finished by reaming, and round, parallel and smooth surfaces are thus cheaply produced. The pistons are finished by grinding, not because a ground surface is wanted, but because grinding is the simplest, cheapest and most accurate way to size them.

* * *

The man who does his work just as well when he knows the boss's eye is not on him as when it is, is the one who does not need watching.

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WORK OF THE GARDNER PATTERN-MAKER'S DISK GRINDER

During a recent editorial visit to the fine new plant of the Gardner Machine Co., Beloit, Wis., we were shown some of the remarkable work done in patternmaking with the Gardner patternmaker's disk grinder that was illustrated and

Fig. 1. Patterns made on the Disk Grinder—Note Different Kinds of Wood used

described in the May, 1910, number. This machine, with very simple appliances, is made a most efficient and economical woodworking tool, as is shown by the fact that it and a band saw are the principal machines used in the company's own patternshop. Not only will it quickly shape most of the circular pieces in core work ordinarily turned up in the lathe,

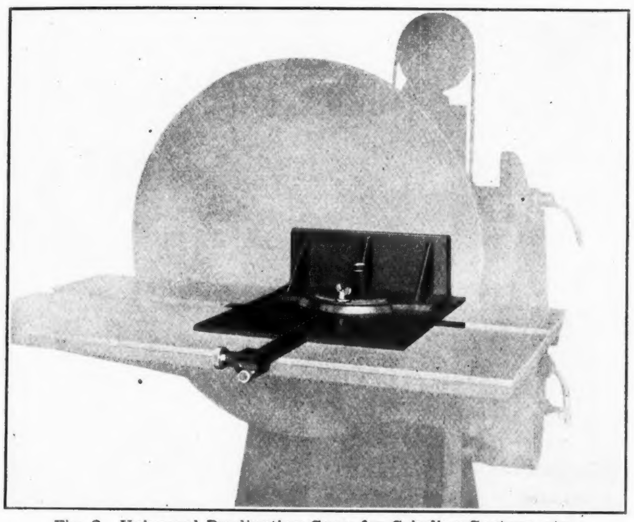


Fig. 2. Universal Duplicating Gage for Grinding Sectors, etc.

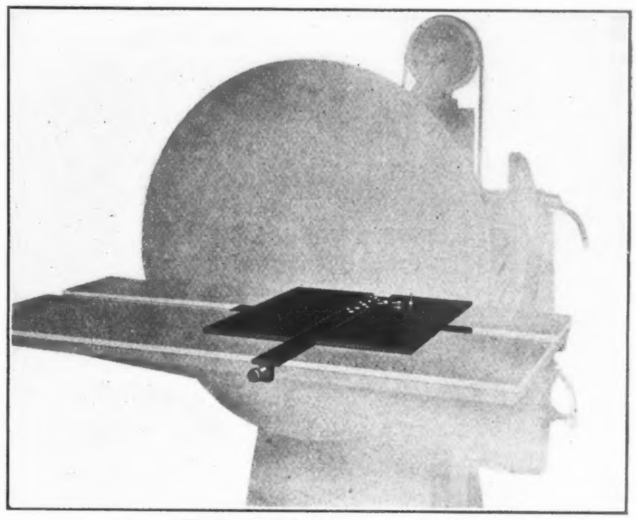


Fig. 3. Circular Core-print Gage

but a grade of lumber can be used that would be worthless if the attempt was made to work it with ordinary tools.

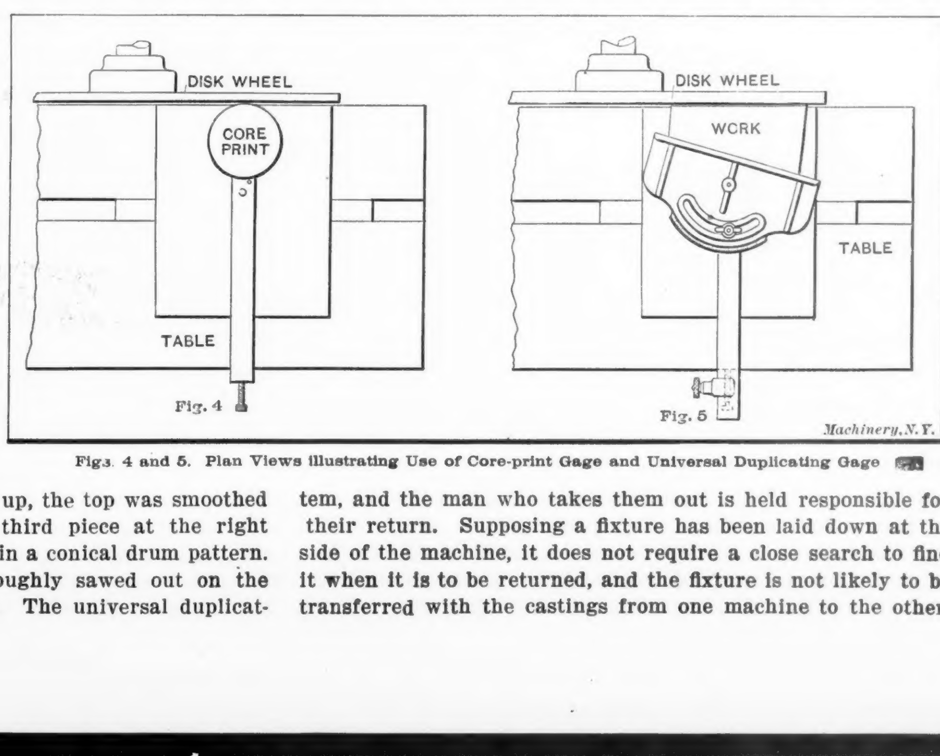
Fig. 1 shows three sample patterns made from several kinds of lumber to illustrate the possibilities of the machine for close and accurate jointing of angular parts, use of poor lumber, etc. Some of the lumber would be considered good only for firewood in most patternshops. Imagine for instance the prospect of making the hexagon nut pattern, shown in the center, from a piece of pine containing a large hard knot, without breaking a few tools and the third commandment. Again, note the soft pine sector containing a large hard knot in the top of the larger pattern at the left. Not only is this piece worked smoothly, but the joints are as close as the most discriminating cabinet maker could require. The other sectors in the tops of this pattern are oak, walnut, cherry, birdseye maple, and birch, all of which were jointed and finished on the disk grinder. After being glued up, the top was smoothed off with the same machine. The third piece at the right illustrates the fitting of taper staves in a conical drum pattern.

In fitting such parts, they are roughly sawed out on the band-saw and then ground to shape. The universal duplicating gage used for grinding tapering parts, such as sectors, etc., is shown in Figs. 2 and 5. This gage is graduated from zero to 45 degrees in either direction from the parallel position, and it has an adjustable stop-screw that regulates the amount of stock removed. Instead of sizing each piece by grinding to a scratch line, this gage with its stop enables any number of duplicate pieces to be made.

Another useful attachment is shown in Figs. 3 and 4. This is known as a "circular core-print gage," and it is used for producing round or curved surfaces. Core-prints are built up from roughly sawed circular pieces, and then ground to an accurate circle in a jiffy with this attachment. The work is pivoted on a pin or center located at the required radius from the disk. Three of these pins and the holes in which they fit are shown in Fig. 3. Circles of different radii can be ground and the gage has an adjustable stop-screw that regulates the amount of stock removed and enables the production of duplicate work. To grind a piece tapering, it is simply necessary to tilt the main work-table to the required angle. With this simple attachment a rough circular piece, say six inches in diameter, can be ground smooth and true on the edge in less time than it takes to describe the operation.

* * *

In a manufacturing plant where there are a large number of castings passing through the shop, it is sometimes a difficult matter to distinguish between the fixtures used for holding these castings during the various machining operations and the castings themselves, especially when the fixtures resemble the castings. Gould & Eberhardt, Newark, N. J., manufacturers of shapers, automatic gear and rack cutting machinery, paint all their jigs and fixtures with red paint, which is an effective means of distinguishing them from the castings. The jigs and fixtures are taken out from the store-room by the check system, and the man who takes them out is held responsible for their return. Supposing a fixture has been laid down at the side of the machine, it does not require a close search to find it when it is to be returned, and the fixture is not likely to be transferred with the castings from one machine to the other.



Figs. 4 and 5. Plan Views Illustrating Use of Core-print Gage and Universal Duplicating Gage

LETTERS ON PRACTICAL SUBJECTS

IMPROVEMENTS IN CENTERING MACHINE

In a shop where the writer was once employed, a commercial centering machine of the type shown in the accompanying halftone, Fig. 1, is used for centering small pieces cut off from cold rolled bar stock. The principle of the action of the machine is as follows: The center drill is held in the tailstock spindle, and clamped by set screw *A*. The work to be centered is driven by means of a tapered hole in the end of spindle *B*. This tapered hole is knurled on the inside, so that it will easily take hold of the corners of the stock to be centered. The large end of the hole is 2 inches in diameter and the small end ¼ inch, so that the machine has a range for stock of from about 5/16 to 1⅞ inch diameter. The work to be centered is pressed by the hand of the operator into the V-block *C*, which latter is adjusted forward or backward on the cross-slide shown, so that the proper center can be obtained for different sizes of stock. When the V-block has been properly adjusted, the operator can center the pieces at a very rapid rate, as the machine is never stopped, and all he has to do is to put one end of the piece into the hole in the spindle, press the cylindrical part of the piece into the V-jaw, and feed the drill into the end to be centered.

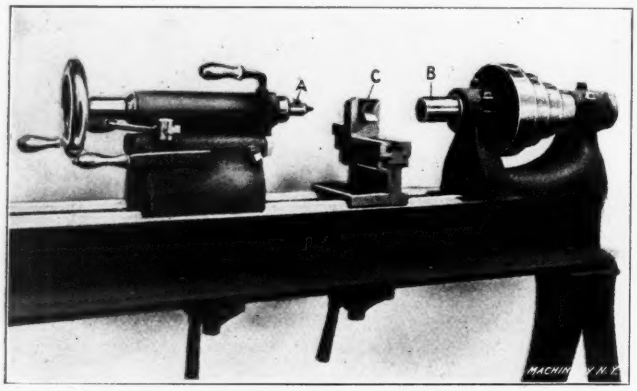
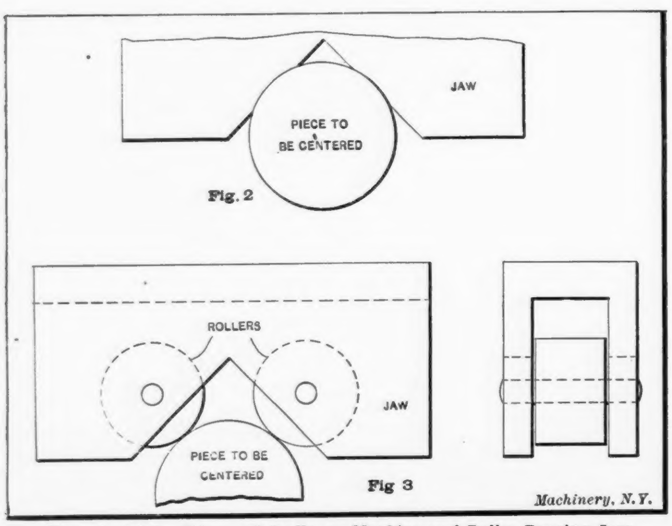


Fig. 1. Centering Machine on which Improvements were made



Figs. 2 and 3. V-jaw originally on Machine and Roller Bearing Jaw substituted

Some improvements on this machine were, however, found desirable. It is the object of this article to describe these improvements. When several thousand pieces were to be centered, and it was expected that all should run true within 0.001 inch, it was found that small grooves would wear in the sides of the V-jaw, as indicated in an exaggerated manner in Fig. 2. Evidently this made the center at the end come out of true, the operator always pressing the piece to be centered against the V-jaw, and hence into the grooves, and unless the operator watched out for this difficulty and re-adjusted the position of the V-block, he would be likely to get several hundred or even thousand pieces out of center, the error being greater as the stock to be centered wore into the V-jaw. To remedy this defect, hardened rollers were provided, mounted on hardened studs, as shown in Fig. 3, and as the friction between the rollers and the piece to be centered is almost imperceptible, there is practically no wear whatever on the rollers, and the only possible cause for the pieces being "out of center" is the variation in the diameter of the stock, which, however, is not over 0.001 inch.

Another difficulty met with was that if the body of the center drill did not fit the hole in the tailstock spindle exactly, the binding set-screw *A*, Fig. 1, would press it down to the bottom of the hole in the spindle, and the point of the drill would not be exactly in line with the headstock spindle or the center line of the work, thus not only centering the stock out of true, but in many cases breaking the drill part of the center reamer. In order to make it possible to hold the center drill true at all times, a universal chuck was mounted at the end of the tailstock, as shown in Fig. 4. At the front end of the chuck a stop *D* was also provided, in the form of a bushing placed over the center drill, and with part of the outside end-surface cut away as shown, in order to reduce the friction against the end of the piece to be centered when brought up against this stop. By means of this stop it is possible to obtain exactly the same size of center in all the pieces, even if the pieces to be centered should vary in length, in which case a positive stop, as provided with the machine, is useless. These improvements greatly increased the usefulness and accuracy of the machine, and were comparatively inexpensive.

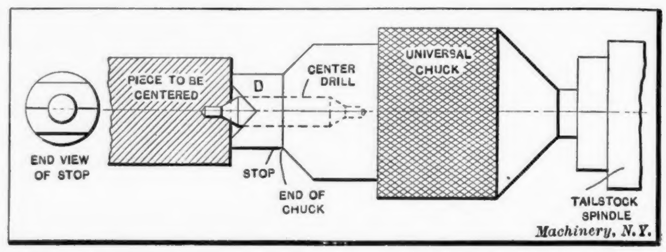
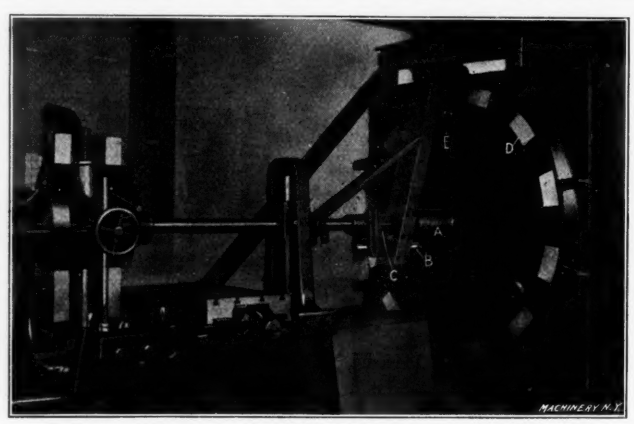


Fig. 4. Universal Chuck for Holding Center Drill, and Stop for Drill Feed

CORRESPONDENT

THE MACHINING OF A LARGE STEEL CASTING

The accompanying illustration shows the method employed in the shops of the Twin City Rapid Transit Co., St. Paul, Minn., for machining a large steel casting. This method was originated by the shop foreman, Mr. John Hallberg. The casting is the base for the turret of an eight-ton wrecking car. The base and the turret which carries the derrick were both machined in the same manner. The dimensions of the casting shown in the illustration are as follows: The base is 8 feet square; length of hub plus thickness of casting, 2 feet; diam-



Method of Setting up and Machining the Base of a Derrick for an Eight-ton Wrecking Car

eter of hole through hub, 6 inches; outside diameter of hub, 9 inches; and the length of the hub projecting from the casting, 14 inches.

This difficult piece of machining was accomplished with a No. 32 Lucas precision boring machine. The capacity of this machine is 2 feet swing over the carriage, with the boring-bar at its highest position. To machine, the casting was placed at the end of the machine against a pillar of the building, and supported by wooden framework. An extension bar was connected to the boring-bar, passed through the hole in the casting, and supported at the rear end by a rigid bearing.

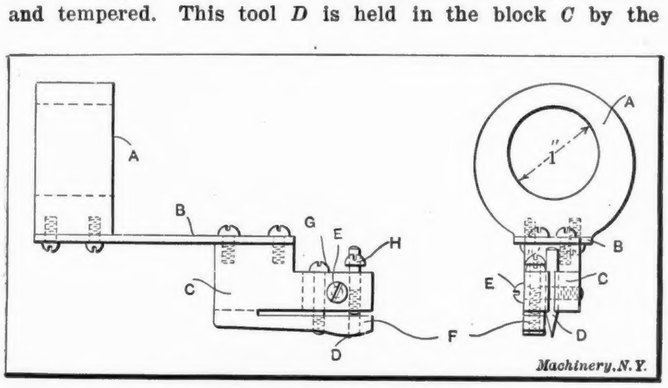
The outside diameter of the hub *A* was turned with a tool held in the short bar *B*, this bar being held in a bracket *C* connected to the extension shaft. The babbitted bosses *D* were faced by a tool held in tool-slide *E*, actuated by a star feed.

St. Paul, Minn. FRANK L. ZAHLER

A GRADUATING TOOL FOR FINE LINES

The writer at one time had a 14-inch vernier to graduate when he was employed with the United States Cartridge Co. This scale was to be used on their chronograph, an instrument which is used for calculating the velocity of bullets fired from cartridges loaded with various powders and charges. The graduating was accomplished in a milling machine by locking the spindle in its bearings, and holding the device shown in the accompanying illustration on a cutter arbor by the eccentric collar *A*. The work was held lengthwise on the table, and the table was moved forward for each graduation by using the micrometer dial.

The stops on the cross-slide for the in-and-out movement of the table were set for the length of the longest line, and parallel strips of different thicknesses were inserted between the stops, so as to make provision for the variation in the length of the lines. The lines were cut by means of a tool *D* of drill rod, which was made with a sharp V-point, hardened and tempered. This tool *D* is held in the block *C* by the



A Graduating Tool of Simple Design

screw *E*, the block *C* being split as shown. The lower portion of the block *C* which forms a sort of shoe at *F*, is adjusted by the screws *G* and *H*, and rests upon the surface of the work to be graduated, only allowing the cutting tool to project in to the required depth.

When raising the work by means of the elevating screw to take a cut, instead of stopping when the shoe *F* touches the work the table is raised slightly higher, say 0.010 inch, so that sufficient pressure is brought to bear upon the broad flat spring *B* to overcome the resistance of the cut and insure that the shoe is always in contact with the work, even if the surface is slightly bent.

This tool was not expensive, and was comparatively easy to make. In making the device, the precaution was taken to avoid using any pivoted joint, plunger and spring, or any working fits whatever, which would have a tendency to make it inaccurate. S. J. PUTNAM

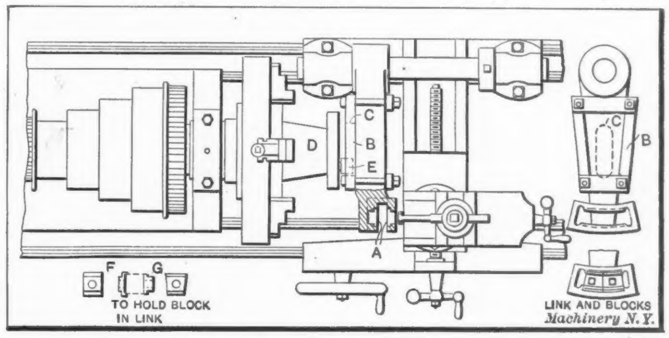
Bentley Manor, N. Y.

A LINK AND LINK-BLOCK JOB

Sometimes a job will occur in machine shop practice that is different from anything that has previously been done. Such special jobs are somewhat expensive, but this is of minor importance when the piece required is a necessity and when a good job is demanded.

In the accompanying illustration the view to the right shows the piece—a rocker arm—quite clearly; the other view shows it in position in the lathe. This rocker arm or lever is a steel forging having a circular slot machined concentric with the bored hole in the end; the end was also slotted radially, as indicated at *A*. This divides the circular slot into two portions, these two portions being cut down on the inside, forming a T-shaped cross-section of each part, which fits the flange of the corresponding link-block.

It was possible to do the work on either the planer, slotter, shaper or lathe, but the latter appeared to be the most suit-



Lathe set up for Machining Link and Link Block—Pieces for Holding Latter in Lower Left-hand Corner

able; the illustration shows how the work was done, after all the stock except enough for finishing had been drilled and chipped out. The piece was secured on a shaft which was mounted in bearings on the lathe carriage, these bearings being approximately level with the center line of the lathe. Adjustment was made to bring them exactly so, when the shaft was babbitted in the bearings in its position. A plate *B* with an elongated slot *C* in it was bolted to the back of the link, a cast-iron nipple *D* secured in the lathe chuck was fitted with the small roller *E* which engaged with the before-mentioned slot *C*, so that as the chuck revolved, an oscillating motion was given to the link. The amount of this oscillation could be adjusted by changing the throw of the roller *E* through the nipple *D*, which is merely held by the lathe jaws and is, therefore, adjustable. During the operation of machining, the carriage remained in a fixed position; the cross feed and compound rest, the latter turned at right-angles to the work, provided the necessary means for machining.

To finish the blocks, pieces *F*, such as shown in the lower part of the illustration, were made to hold them. One side fitted the circular slot while the other received the roughed-out block *G*, as indicated by dotted lines between *F* and *G*, a hole through each allowing them to be bolted to the face of the work, all as shown in the lower right-hand corner; thus the blocks could be finished while the main piece was still in the lathe. By this means a very satisfactory piece of work was obtained. C. L. NEWTON

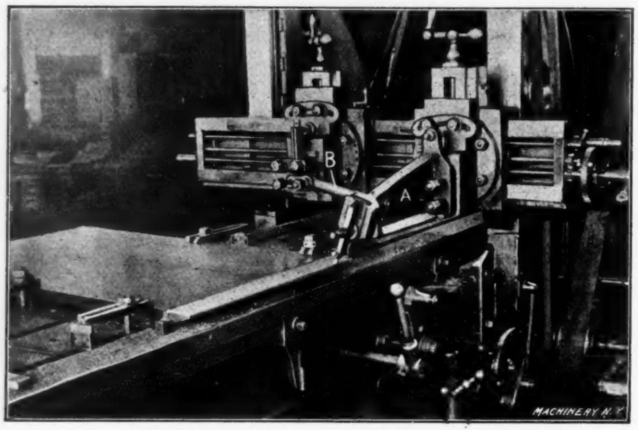
Pueblo, Colo.

EXTENSION TOOL-HOLDER FOR THE PLANER

In nearly every shop can be found some form of extension head for holding the tool when planing work which is longer than the distance between the housings. Some of these devices are provided with down feeds and are bolted to the saddle, while others have a swivel clapper box on the work end. The majority, however, consist only of a cast-iron bracket, which is slipped over the bolts of the clapper box, and in which the tool is held by a set-screw. With this latter construction the tool is subjected to harsh treatment on the return stroke, as the extension block allows the tool to drag, thus soon destroying the sharp cutting edge. Another objection to the extension head is its tendency to spring sideways when a good cut is being taken, and also to spring out of the vertical line when a facing cut is being taken.

We had considerable work that would not pass through the

housing of the planer and, after having tried a number of different extension holders, we struck on the one shown in the accompanying illustration. This consists mainly of a casting *A*, held to the main tool-holder by the bolts in the clapper box. On the forward end of the arm *A* is a block carrying a toolpost. This block can be swiveled through a short arc, and is



Extension Tool-holder of Rigid Construction

held to the arm by two nuts on the rear face of the front end of the bracket. The bracket is also additionally supported by means of the arm *B*, which is fastened to the casting *A*, and also to the other tool-head, as shown. This arm is made from pipe section. When using this device for facing, both toolheads are set to feed downward together. This makes a combination sufficiently rigid to enable a cut to be taken well within the capacity of the tool held in the tool-holder.

Middletown, N. Y. DONALD A. HAMPSON

CUTTING AN OCTUPLE THREAD

The piece of work shown in Fig. 1 is part of the focussing mechanism of a certain make of prism binocular, and was originally made of aluminum, apparently alloyed with zinc; this is a rather poor material from which to make narrow faced gears, particularly when they are to be used by people

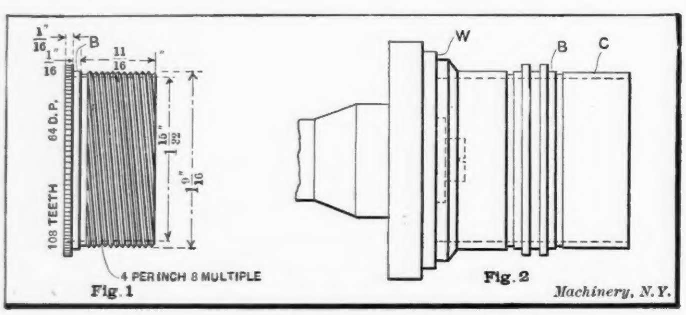


Fig. 1. Piece of Work to be repaired Fig. 2. Method of Chucking Stock for a New Piece by Soldering to a Faceplate

who are not mechanics. Both gears in this instrument had many of their teeth stripped off, and had to be made new, out of brass. The threaded parts were in good condition, but there did not seem to be any good means of fastening a brass gear to the aluminum threaded tube. If the large hole through the piece had not been in use up to its full diameter, then a brass gear could have been made with a slight hub to go inside the aluminum tube, and six small rivets could have held them together, but in that case the rivets would have had to be put in the threaded part or in the bearing strip *B*. Either of these methods would have been objectionable, as the nut in which this tube moved, was at times screwed clear up to the shoulder, and the nut could not be made shorter, as it was only 3/16 inch long. Solders adapted to aluminum would be uncertain in their hold where the surfaces in contact were as small as in the piece of work under consideration. All things considered, it was decided that the best way out of the difficulty was to make the entire part new in one piece.

A piece of tubular composition casting was cut off a little longer than necessary to make the two pieces, and this was soldered onto a brass washer *W* which was fastened to a small faceplate in the bench lathe, all as shown in Fig. 2. In this position the hole was first bored to size through the full length of the casting. The places for the two gear blanks were then turned to size and the teeth cut, after which the bearing *B* on the outer piece was turned to size, and part *C* was turned and threaded; the parting tool was then run in between the two gears. The outer piece was next placed on an expanding chuck and the back surface of the gear finished off true and flat. Having the first gear out of the way, the end of the second gear was turned true and then unsoldered from its washer, turned end for end and placed on an expanding chuck, the operations as on the first piece being repeated.

As shown in Fig. 1, the thread is four turns per inch, but there are eight threads; that is, it looks like a thread of 32 per inch, but with a greater lead. The tools used in cutting this thread are shown in Figs. 3, 4, 5, 6, and 7. The steel screw and solid brass nut shown in Fig. 7 were the only tools made specially for the job in hand, the others being part of the regular shop equipment. Fig. 3 shows two views of an iron casting fitted to the slide rest, and ordinarily used as a boring-tool holder, the ½-inch hole through it being at the height of the lathe centers. It will take a ½-inch round bar, or smaller sizes by means of split bushings like Fig. 5. Fig. 4 is a threading tool for either inside or outside chuck work,

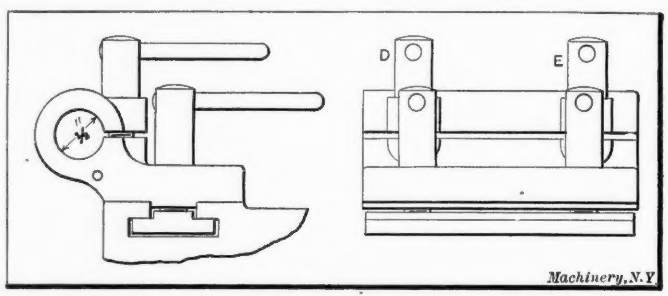
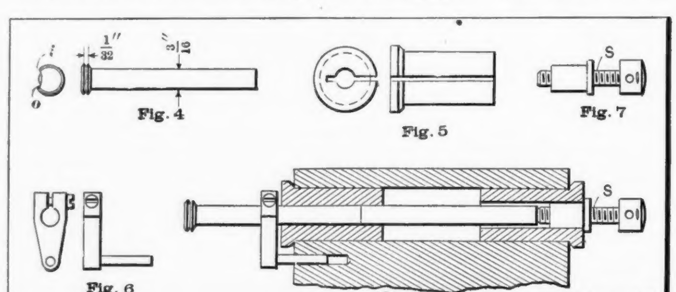


Fig. 3. Boring-tool Holder utilized in Cutting the Octuple Thread

and is held in the boring-tool holder by one of the split bushings, the cutting lip *i* being used for internal threading, and the lip *o* for outside work. As the shank or stem of this tool is at the same height as the lathe centers, it has to be set with its cutting lip below the center to give the necessary clearance, and this somewhat distorts the shape of the thread from its 60-degree form, but not enough to be injurious.

Fig. 6 was made to be clamped on a threading tool like Fig. 4 for boring and threading alternately, so as to avoid adjusting the thread tool for height each time it was placed in its holder; it proved very useful on the present job, as it enabled the thread tool to be fed out of its holder without rotating.

Fig. 8 is a sectional view through the boring-tool holder as assembled to do this multiple-threading job. The screw *S* has



Figs. 4 to 7. Component Parts of Threading Device. Fig. 8. Assembled View of Threading Device

32 threads per inch, and was cut with a single-point tool in order to get a more accurate lead than if cut with a die, although a die was used to bring it to size. Its head has a single hole drilled crosswise, and one side of the head is marked with a file nick, as shown in Figs. 7 and 8. As the lathe was geared to cut four threads per inch, the tool would cut two of the threads, and after these were cut to depth, the clamping screw *D*, Fig. 3, was slightly loosened, the screw

S given two complete turns, which pushed the tool 1/16 inch further out of the holder. The screw *D* was then tightened, and two more threads were cut. By repeating this operation, all the eight threads could be cut.

It was originally intended to use this method, but when the job was actually under way it was decided to move the tool out 1/32 inch each time, as it would then leave the work in a little smoother condition. If fed out 1/16 inch each time, every other thread would have a burr left on it.

The method of giving *S* one exact turn was to put a wire through the hole in its head and use this as a lever by which to turn it until the wire came in contact with the edge of the top slide dovetail of the slide rest, the file nick in the screw head being a check against giving it ½ or 1½ turn. Thanks are due to Mr. Donald Walters for suggesting the edge of the slide rest itself as a stop for the lever used to turn the screw; the original plan was to fasten a straightedge to the top of the boring-tool holder and let it project over the right-hand end of the holder. WALTER GRIBBEN

Brooklyn, N. Y

COMPOUND BENDING DIE

The illustrations Figs. 2 and 3 show plan, end and side elevations of a die for making the two bends in the piece

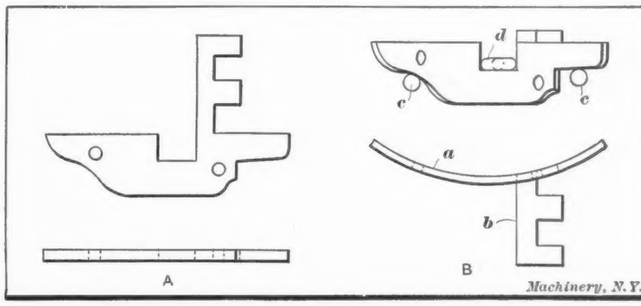


Fig. 1. Blank before and after the Bending Operation

shown at *B*, Fig. 1, the shape of the blank previous to bending being shown at *A*. The die-bolster *A* (Figs. 2 and 3), made

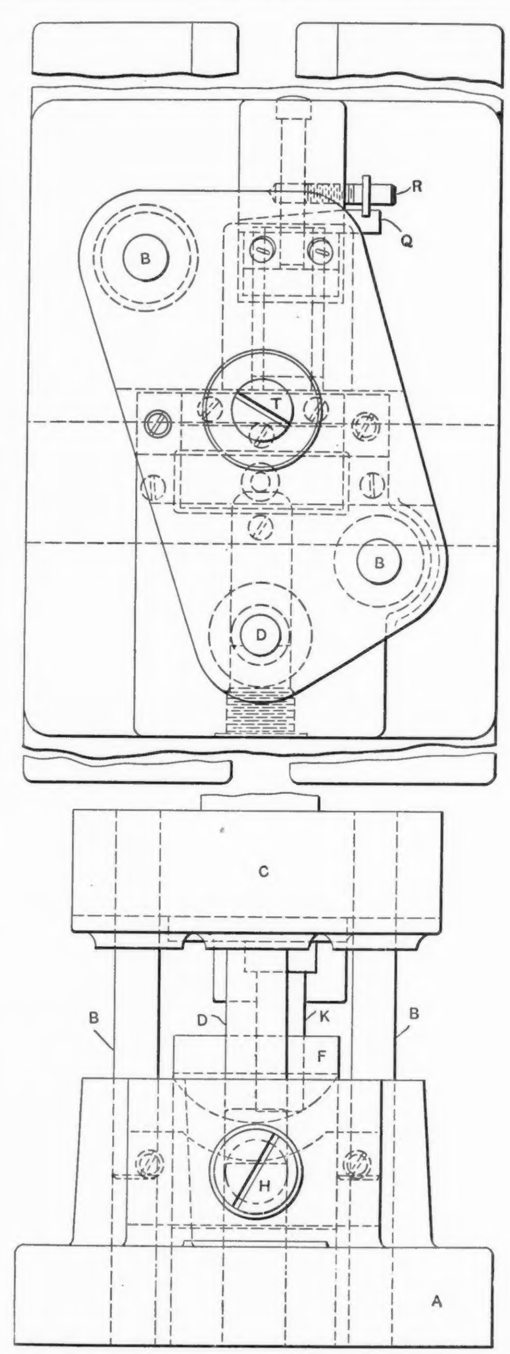


Fig. 2. Plan View and Elevation of Compound Forming Die

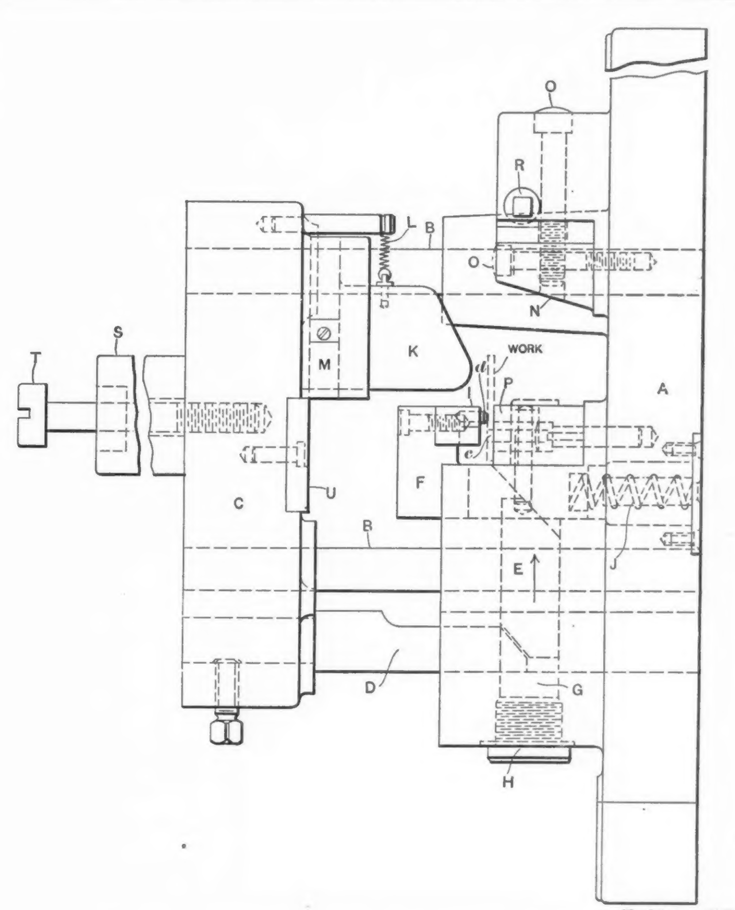


Fig. 3. Side View showing how the Work is located and formed

of cast iron, is bored out to receive the two guide-rods *B*, which are made a sliding fit in the die-holder *A*. It will be noticed that the bosses on the die-holder *A* are made large, sufficient material having been left so that they could be bored for bushings. However, in this case the bushings are not required, and the writer has found that in the majority of cases it is not necessary to bush the die-holder, especially when the dies are not in constant use.

The stud or cam *D* held in the punch-holder presses on a block *E*, which, in turn, operates the bending-die holder *F*. A hardened block *G*, of the same size as *E*, is held by a screw *H*, in the die-bolster to take the thrust of the stud *D*. The stud *D* is made with a 45-degree angle; all of these parts are made of machine steel and casehardened. The movable member *F* or die-holder, carries the die *I*, which, after the bending operations are completed, is returned to its normal position by the spring *J*, held in the bolster. The bend *a*, Fig. 1, is performed with the die *I*, while the bend *b* is made with the punch *K*, which is held to the upper member. This punch *K*

slides in a slot cut in the upper member, and is retained by a spring L against the stop M, when in its normal position.

In operation, the piece to be bent is located in the lower die P in the manner shown at B in Fig. 1, being placed against two pins c, held in the lower die. The blank is also additionally supported when the dies come together, by a pin d held in the die I. This pin is so shaped that it fits the slot and locates the blank properly. When the blank is located in the die P, the punch-holder descends, and the die I makes the circular bend a, which is accomplished by the stud D forcing the block E in the direction indicated, thus drawing down the member F, holding the bending die I. When the stud D has descended 7/16 inch, the holder F comes to rest, so that the blank is held firmly when the punch K acts on it. The punch K then comes in contact with the blank and the adjustable block N. The block N is tapered as shown, and deflects the punch K inward, so that it slides in the punch-holder, and in its descent bends the blank at right angles. The block N is held to the die-bolster A by means of three screws O, and is adjusted inward by a tapered gib Q operated on by a screw R. Having the block N adjustable in this manner makes provision for the blank to be bent to such shape that after the punch retreats it will spring back to the angle desired. The shank S is held to the punch-holder C by a screw T. A hardened block U held to the punch-holder C comes in contact with the holder F, and gives the final blow to the blank. B. P. FORTIN

Hartford, Conn.

THE USE AND ABUSE OF GRINDING MACHINES

At the present time when makers of grinding machines and of grinding wheels are trying to show to the world what work can be done by them, it may be interesting to some to know the treatment that the machines get. The following is an incident of how a machine, called by its makers a "No. 1 universal grinder," was abused. When the machine arrived at the works to be erected, the foreman who was to have charge of erecting it, as soon as the case was opened took out the blueprint showing how to set up the machine and also the book of instructions. The machine was then unpacked and the place where it should be erected was decided on. The foreman got a man to erect the machine and countershaft, but did not give him either the blueprint or the book of instructions. However, the man got the belts on and the machine ready to start.

Some time after it was set up, a foreman from another room, in passing, started the machine, and was delighted with the speed at which the grinder was running. It was not long before he had a chuck made, and a boy was set to work polishing disks on it, which could easily have been done on a polishing or buffing wheel.

After two months of this work, another man came along and thought he would use the machine for what the makers had intended it, *viz.*, the grinding of hardened steel pivots and a mild steel mandrel, with the wheel that had been sent with the machine. He was not satisfied with the results, and wrote to the makers stating what he was doing, and asked for their advice. A courteous reply was received, stating what wheels were best to use for certain classes of work, and also a copy of their book of instructions. They also stated that they had put a copy of the book of instructions in the case with the machine. This man then asked the foreman why he had kept the book and not placed it with the machine, when he was very bluntly told that nobody wanted to see it, and the best way to use the machine was to find out. This man then thought that he would ask the firm's works manager to get him the wheels which the makers had recommended, and here again he was put off with a blunt answer, and was quickly asked what he knew about grinding wheels, and where he obtained his information; he was also reminded that he had better leave such matters to the office, and use the wheels provided.

Among the work tried out on this machine and said to be a failure were piston rods for air pumps. These rods varied in length from about 8 to 14 inches and ¾ to 1½ inch in diameter. When these were tried out, no steady-rests of any kind were put on the machine, and no water was used, so it is evident that they would spring from the center, and, of course, not be parallel. Another job for the machine was some hardened steel cones. Now the taper on these cones could not be obtained by the swivel table, and it never occurred to the operator to set over the wheel-bed, so he drilled more holes in the table, and set the swiveling table over. This is how the cones were ground—with the swivel table hanging half off.

This machine has now been set up for over ten years, and in that time the belt from the countershaft to the wheel spindle has been broken a number of times, and to-day there are upwards of eight belt fasteners in it, whereas for good work one is sufficient. One day a man was sent to the machine who had never seen it before; he ran the table into the wheel when it was going at full speed and the way that wheel flew to pieces was marvelous. One of the pieces left its imprint in a wall eight yards away.

The other machine which the writer saw abused was a No. 2 surface grinder, manufactured by the same company. This machine is not as old as the other, but has had a lively life of it. The countershaft is set at right angles to the main shaft, and its belt is forever breaking, coming off the pulleys and giving an endless amount of trouble. After the machine was set up, a magnetic chuck was obtained for it, and as the other machine had a water tank and pump on it that was never used, it was removed and placed on the surface grinder. The base of the machine after the water tank was applied was flooded with water, and sawdust was used to dry it, which gave the machine the appearance of having been used in a sawmill. After the magnetic chuck had been flooded a number of times, one of the coils burned out, so it was removed and it is now only a matter of time before the whole chuck will be put out of business.

The writer once asked to have charge of these machines, but was told that the work he was doing paid them better than if he did the grinding, and that they were going to keep someone on the machine when they got plenty of work to do. That was over eight years ago, but nothing has been done since, so we simply go on in the old sweet way.

ENGLAND

BENDING COPPER EYES FOR WIRE SLINGS

Fig. 1 shows a neat bending device for making the copper eye shown in Fig. 2. Fig. 3 shows the tube of special design used for its production. The eye as shown in Fig. 2 is ready to be applied to the sling. These slings are made of fine brass wire, a loop being left in each end for the copper eye.

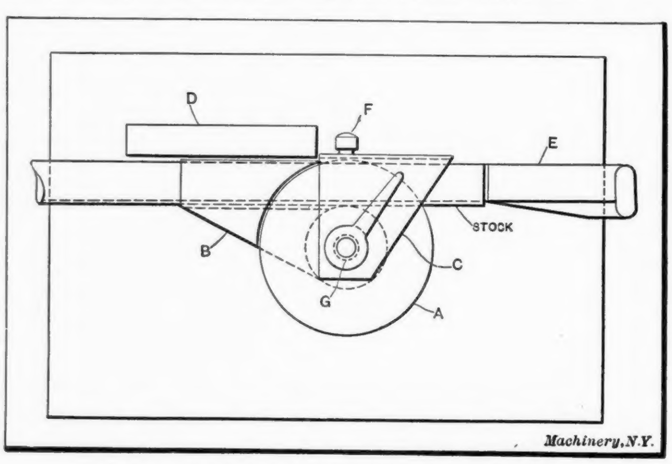


Fig. 1. Device for Bending Copper Eyes for Wire Slings

Fig. 4 shows the various details that enter into the making of this jig; the lettering throughout all these figures is the same. A sheaf A, split in the plane of rotation as indicated, has a grooved diameter equal to the inside diameter of the

eye, the groove being of the same section. This sheaf is attached to a table. A piece *B*, made of the form shown, has the angle of taper *b*, the shape of the enclosed triangle corresponding to the inside section of the eye. *C* is a piece of angle-iron with a ⅜-inch web arranged in the piece as shown in Fig. 1. A stop *D* is so arranged as to just allow clearance for the eye stock to pass between it and the sheaf. When equidistantly located each side of the center line, the chain or mandrel *E*, which is inserted inside the eye stock, is tightened down by the set-screw *F* in the angle-iron piece *C*, before mentioned. By twisting the flexible mandrel *E* around until it comes in line with the other side of the part *B*, the eye will be formed, the eye stock being twisted symmetrically about

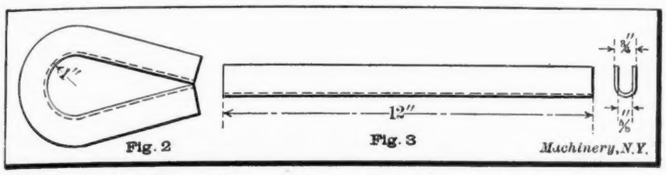


Fig. 2. Finished Copper Eye Fig. 3. Copper-Eye Stock

the sheaf, as it is secured by the set-screw *F*. By loosening set-screw *E* and removing the nut *G*, the upper half of the sheaf may be taken off permitting the removal of the copper eye.

The method of making this flexible mandrel *E* is important, as it is principally because of its construction that this method of producing the eye is possible. The manner in which the parts are made is indicated at *H* in Fig. 4. Pieces such as are shown by the heavy lines are blanked out, their size being such that when arranged in a circle as shown and bored out, they will reduce in inside diameter to the diameter at the bottom of the sheaf indicated by the light lines. In order that they may be turned in this position, two circular layers of

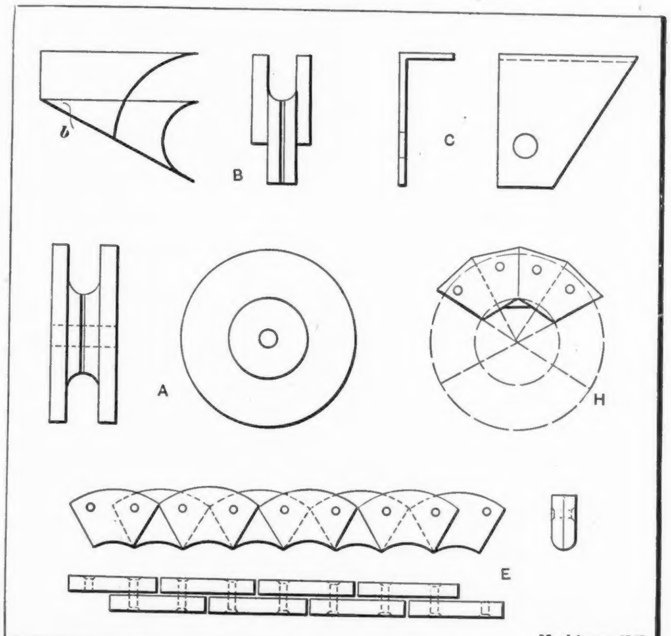


Fig. 4. Details of Bending Device and Method of Construction

these lengths are arranged as indicated and are soldered together in that position; they are then placed in the lathe and turned down as desired, forming a cross-section of ring, as indicated to the right at *E*, Fig. 4. The ring may then be removed, heated and the solder scraped off after which the joint-holes may be drilled. These joint-holes are located near the outside of the chain in order to allow free action with no binding at the corners.

Before this tool was designed the making of these copper eyes was an expensive proposition. Many unsuccessful attempts were made to produce a tool that would do the job, but none of them gave satisfactory results until this one was tried out. As will be seen from the foregoing description it is very simple and requires no skill on the part of the operator.

J. A. WHITCOMB

Kenosha, Wis.

THE FIELD FOR GRINDING—A COMMENT

Having read with much interest the article entitled, "The Field for Grinding," by Mr. C. H. Norton, in the January number of MACHINERY, engineering edition, and "Rough Turning vs. Rough Grinding of Crankshaft Pins," by Mr. H. C. Pierle, in the March number, engineering edition, the writer feels that a few words on the points brought out by these enthusiasts in their different lines may be of interest at this time when coming from a layman and not a manufacturer.

Mr. Norton is well known as a pioneer in his field, and if it were not for the optimism displayed by men of his type the manufacture of machine parts by modern methods would never have made the great strides that it has during the past few years. The writer's experience in the machinery field leads him to believe that the results claimed by such enthusiasts have been actually obtained, although doubtless many will not agree with this statement. However, practical experience would seem to prove that the results must have been obtained under ideal conditions and not under those found in the every-day routine work of commercial manufacturing.

It is only necessary to look at other branches of the trade to see that this fact holds true. One of the best examples, and one with which even the smallest shops are acquainted, is the great result claimed by the makers of certain grades of high-speed steel. But how many can get the results claimed day after day? Very few. In several places in which the writer has worked it has been the same story: "Well, so-and-so gets certain results; why can't we?"

This same trouble obtains in other branches of the trade, and not long ago an instance came under observation which will serve as a good illustration. A salesman was trying to sell a certain well-known make of turret lathe, and from the argument, figures and estimates presented, he seemed to make a good impression upon the superintendent of the factory, who answered, "Yes, I know what you claim can be done, for we have one of your machines on which we accomplished wonderful things, but with only one man who is not with us now. If you will obtain an operator who can produce the results claimed I will be in a position to place an order for the second machine before the manager." Not having seen the second machine it must be taken for granted that the salesman was unable to find the operator.

Mr. Norton's claims for rough grinding of crankshafts cannot be looked upon as impossibilities, for in his own factory where he has every facility for doing this special class of work, and men properly trained to produce great results, it is possible to accomplish what would seem incredible to a skeptic. The same operator, however, who in Mr. Norton's factory produced the seemingly impossible results, if put in another factory and required to keep up this rate week after week, would soon tire of the job, as in most cases he is only required to obtain such results before a prospective customer or visitor.

Mr. Pierle's article appeals to the writer as being nearer the methods of manufacturing that should be employed in the commercial manufacture of crankshafts. He fully enumerates the disadvantages of grinding a drop-forging, and agrees with Mr. Norton as regards rough turning. There is a point here that should be mentioned; the average lathe-hand seems to think that because he is only roughing out, there is never going to be a finish, and a carelessness develops amongst them exemplified by the deep gouges often produced in their work, which afterward cannot be removed by the grinders. A careful supervision therefore, is still required in the lathe department, even though it is only rough turning that is being done.

Labor cost on grinders is an item in which there is a great deal of variance among shops. In small shops where there are only one or two grinders, wages are, as a rule, high on this class of work; but in larger factories where there are dozens of these machines, they will be found to be operated very efficiently by apprentices. The General Electric Co. in Lynn employs upon the finest grade of work apprentices at a low

rate per hour, which proves that it is the supervision given the department and not the high wages paid that makes for results. Grinders are often put in charge of men who are lathe specialists and depend on high-priced help for results, whereas if they had the proper training they would be in a position to train good handy men to produce the required results. This type of man is found in nearly every shop and takes pride in his work, in most cases staying with a firm longer than will a machinist. JOHN F. WINCHESTER

Brooklyn, N. Y.

COMPOUND TRIMMING DIE FOR DROP FORGINGS

A compound trimming die which has been found useful for trimming the flash from drop forgings, and also for piercing holes in them, is shown in the accompanying illustration. This die is used for trimming the piece shown, and also punching the hole *a*, and shearing the parts *b* shown by the dotted lines. Previous to the adoption of this type of trimming die, the ordinary trimming die was used, in which the flash only was trimmed off, so that if the forging required to have a hole pierced in it, this operation had to be done in another die. This, as can be seen, would increase the cost of the product considerably.

In using the die shown in the illustration, it is customary when holes are to be pierced in the blank to make the drop-forging die of such shape that the hole in the part will be partly formed, leaving only a small internal web to punch out. The perspective view, Fig. 1, shows the general construction of this die, while the cross-sectional view, Fig. 2, shows more clearly the method of applying the stripper-plates to the punch and die, and also the piercing punch and guide pins. The die *A* is fastened to the punch-holder *B*, while the punch *C* is fastened to the die-bolster *D*. The member *B* which holds the die is grooved for the reception of a strip *E* into which are screwed the bolts *F*. These bolts, as shown, pass through the die-block *D* and operate the strap *E* to which the stripper *J* is held.

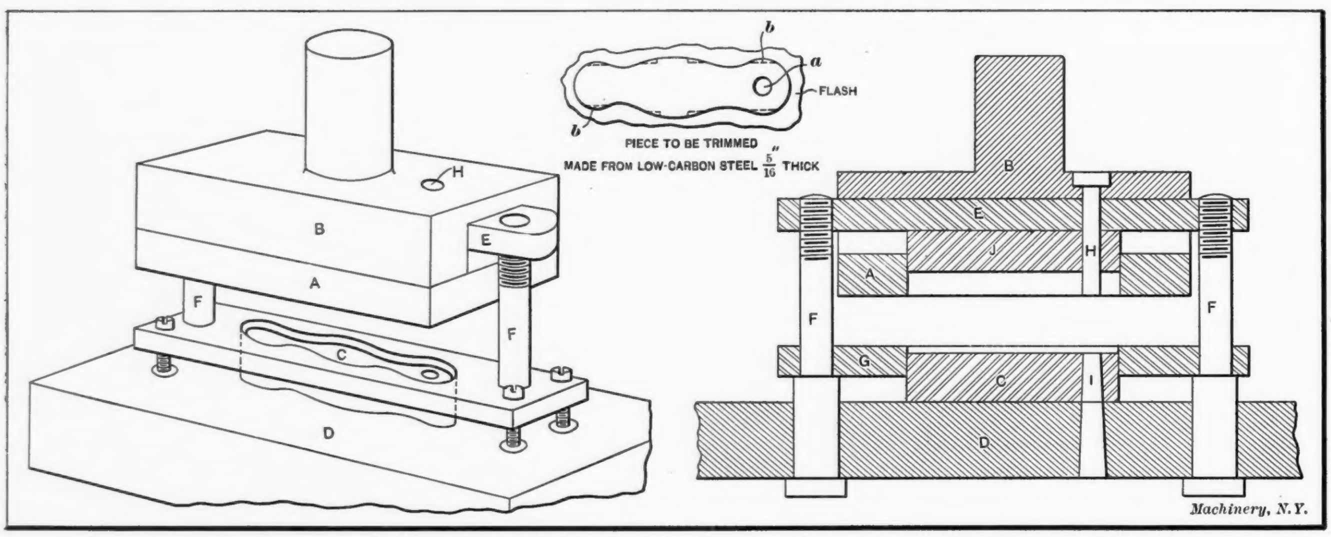


Fig. 1. Perspective of the Compound Trimming Punch and Die

Fig. 2. Sectional View showing Method of Applying Stripper-plates to the Punch and Die

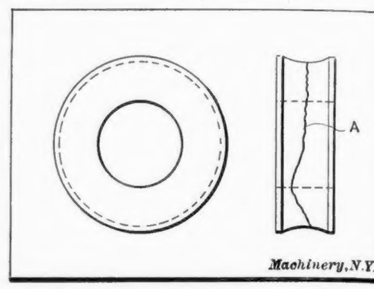
In operation, the blank is placed on the plate *G* which acts as a stripper for the punch *C*. Then as the ram of the press descends the stripper *G* descends out of the way, while the punch *C* forces the piece up into the die *A*, removing the flash. At the same time the punch *H* pierces the hole *a* in the piece. A hole *I* is provided in the punch *C* to allow the trimmings to fall through the die-bolster. When the ram of the press ascends the bolts *F* lift the stripper *G*, and pull down the stripper *J*, which clears the die. This die is set in an inclined press, so that the work and scrap drop out as soon as the ram ascends. C. H. WILCOX

Springfield, Mass.

AN ODD EXPERIENCE IN HARDENING ROLLERS

Many stories have been told of strange things happening in the "oil country;" but perhaps the following account of Vernie's experience in hardening rollers will convince the skeptical that not all the mysteries are confined to that section of the country.

Vernie was getting his first experience in hardening, and indeed was having such marked success that he began to believe himself to be nearing the point where he would be considered a professional hardener, until he tackled the job of hardening a set of rollers, such as that shown in the illustration. Now really, these rollers were very innocent-looking specimens, and no trouble was looked for in hardening; but alas! the unexpected happened, which crushed Vernie's hopes very nearly to the ground. The sad and doleful rehearsal of the facts are as follows:



Rolls subject to Mysterious Cracking

The first pair of rollers was heated and immersed in the bath, but upon removing the second one a crack was noticed as shown at *A*. A little encouragement lifted the drooping spirits of the hardener sufficiently to induce him to harden a third roller, made to replace the broken one, which after hardening, was delivered to the diemaker's bench. Not having occasion to use the roller immediately it was not examined until the following day, when it was found to have a crack similar to the former one. When this was brought to Vernie's attention, he declared the roller to have been free from cracks when it was placed upon the bench, and to determine the truth about the matter the whole tool-room force was called together in a council of war, and after thorough investigation, the following facts and conclusions were settled upon.

1. The roller was sound when delivered;
2. It had lain on the bench nearly 24 hours without being touched;
3. The sun had been shining and cast its direct rays on the bench where the roller lay for a considerable part of the afternoon; and
4. The roller now had a crack.

Conclusion: The heat of the sun must have warped the roller, causing it to crack.

Everyone being satisfied with the conclusion, another roller was made and Vernie was carefully instructed not to allow it to lie around in the sunshine after hardening.

With much fear and trembling this roller was hardened and upon examination it appeared to be perfectly sound,

though caution decreed that a further examination should take place after several hours had elapsed. But mischief was loose, for as soon as the unfortunate hardener turned his back, the sound roller was replaced by the cracked one. Several hours afterward when Vernie came back to inspect the roller —horror of horrors—cracked again; he could hardly believe his eyes; surely the sun had not shown upon this roller. With pallid face, shaking knees, and quivering hand, the humiliated Vernie presented the difficulty to the foreman.

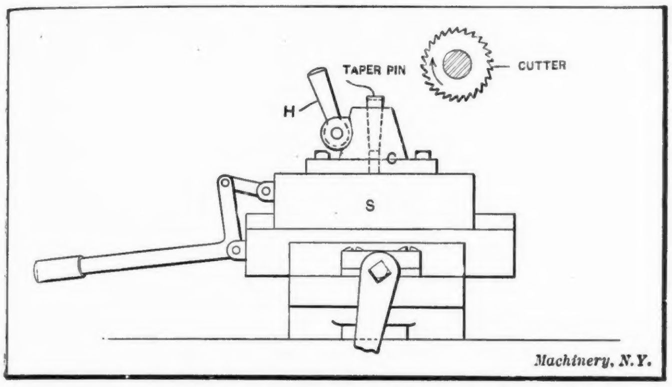
When Vernie confidentially told the diemaker that this "doggoned" roller was cracked again, it was suggested that possibly he had picked up the wrong roller, and the evident amusement in the eyes of the "boys" suggested the secret. To report to the foreman that he had been made the victim of a joke, though offering a measure of relief to his troubled spirit, was Vernie's second humiliation.

Let it be said in fairness to Vernie, that since this experience he has had no difficulty in hardening rollers.

E. J. P.

A MAKESHIFT SLOTTING JIG FOR THE MILLER

At one time we had an order for 600 No. 7 taper pins, which were required to have a slot 1/8 inch deep by 1/8 inch wide, cut through the large end. These pins were waiting



Makeshift Device used for Slotting Taper Pins

their turn to be slotted in a screw slotter, when a call came in to have them done at once. It was therefore evident that something had to be done. The work in the screw slotter could not be stopped, so it was up to the writer to devise a makeshift; the device is shown in the accompanying illustration.

This fixture consisted of a casting *C* which was faced top and bottom and reamed to fit the taper pins. It was slotted, drilled, and tapped, and fitted with a binding screw actuated by the lever *H*. An ordinary vise was then clamped to the platen of the milling machine, and the jaws opened to receive the tool-slide *S* of a hand-lathe. With this simple device it was a very easy matter to slot the pins, and before night the order was finished.

It might appear to some that this fixture *C* would have worked better if clamped directly to the platen, instead of being fastened to the tool-slide *S*; but this was not the case, as the quick-acting slide had a distinct advantage over the more laborious screw feed of the miller.

Middletown, N. Y. DONALD A. HAMPSON

SOLUTION FOR CLEARING BLUEPRINTS

The color of a blueprint can be greatly improved by adding a small amount of bichromate of soda to the water in which it is washed; about one-half teaspoonful to one quart of water is sufficient. When blueprints are rinsed in this solution the high lights come out much whiter and the background much darker, thus making a sharper and clearer print. This adds greatly to the value of the print, as one of the chief defects of a blueprint is that it is generally "mealy-looking," lacking contrast.

Pittsburg, Pa. HOWARD M. NICHOLS

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

BABBITTING BOXES—SPLIT PULLEY HUBS

J. P.—Will some one of MACHINERY's readers give a quick method of babbitting common boxes, pillow blocks, chain and ring oiling boxes? I would like to know what kinds of jigs the leading makers of these boxes use.

J. P.—Where can I get the proper proportions for split pulley hubs? I notice that some pulley manufacturers make split hubs lighter than the solid hubs for the same size of pulley and shafts.

RELIEVING A WORM-GEAR HOB

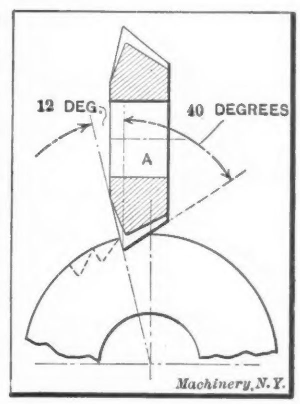
R. H.—How should a worm-gear hob be relieved?

A.—The common method of relieving a hob for cutting the teeth in a worm-gear is by means of a relieving attachment in a lathe. The relief is obtained in the same manner as for a formed tooth milling cutter, but it is, of course, necessary to relieve the bottom and sides of the teeth by the regular worm-thread cutting tool, and then the top of the thread of the worm by another flat-nosed tool. Detailed instructions for making hobs for worm-gears are given in MACHINERY's Reference Book No. 1, Chapter II.

FLUTING SPIRAL MILLS

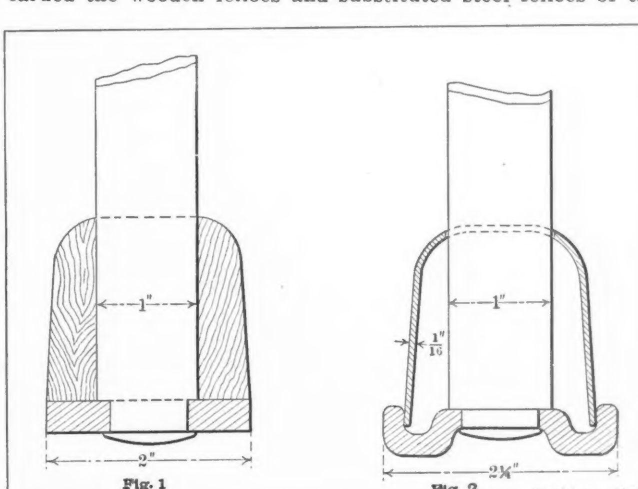
R. H.—What is the quickest and simplest method for setting a milling cutter for cutting the teeth in a spirally fluted milling cutter? The fluting cutter used is of the ordinary double-angle type, with a 12-degree angle on that side which cuts the radial face of the tooth in the cutter to be fluted, as shown in the accompanying line engraving, where *A* is the double-angle fluting cutter having an angle of 12 degrees on one side and 40 degrees on the other, this being the standard form.

A.—Submitted to the readers.



ROLLING RIMS AND FELLOES OF WHEELS

J. G. & Co.—We are about to undertake the manufacture of an all-steel wheel for agricultural machines in Russia and wish to obtain machinery suitable for rolling the felloe and tire shown in Fig. 2. Fig. 1 shows the original wheel made with steel spokes and steel tires but wooden felloes. We have discarded the wooden felloes and substituted steel felloes of the



same shape. Any suggestions that you can make regarding the machinery and methods to be followed in rolling and assembling this wheel will be much appreciated.

A.—The problem is submitted to the readers. A first-class contribution on the making of all-steel wheels of this or similar shape would be acceptable.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO KEEP PENCILS FROM ROLLING

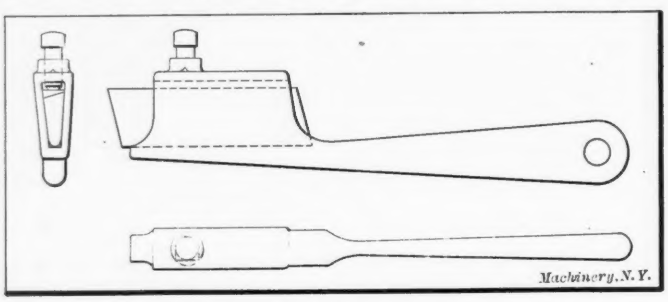
To keep pencils from rolling off the board the method indicated in the accompanying illustration has proved very satisfactory. This consists in wrapping a piece of pasted drawing

paper around the end, bending up one corner so that it forms a fin. The fin acts as a stop and keeps the pencil from rolling. BENJ. BROWNSTEIN

Ellwood City, Pa.

TOOL-HOLDER FOR GRINDING SHORT TOOLS

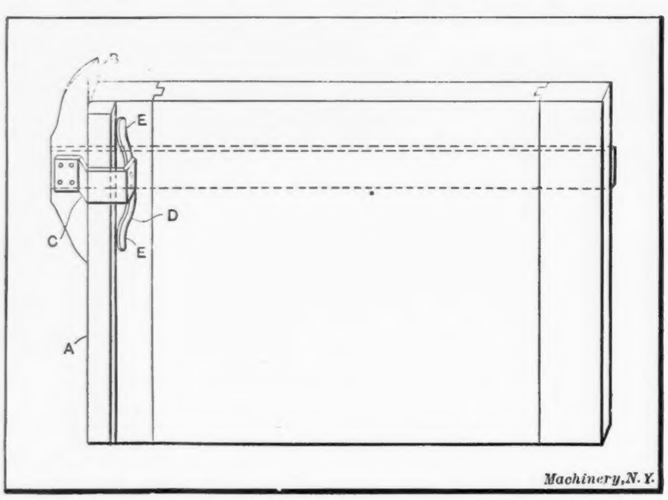
In the town where the writer is located, V-section tools are used to a considerable extent for lathe, planer and slotting tools, in specially designed holders. These V-section tools vary in length from 4 to 6 inches, according to the strength of the section, and it is obvious that unless some means of holding these tools when grinding is provided, the full value or use-



fulness of the tool cannot be obtained each time it is ground. The tool becomes shorter after each grinding, and therefore more awkward to hold by the hand. The accompanying illustration shows a holder that was found very satisfactory for the purpose; it is made of cast steel with a slot cored through to receive the tools which are held in position by the set-screw on top of the holder as shown. P. H.

ATTACHMENT FOR THE T-SQUARE

A device that can be attached to a T-square and that will keep the head up against the drawing-board at all times, is shown in the accompanying engraving. *A* is a piece of wood which is screwed on the under side of the board parallel to

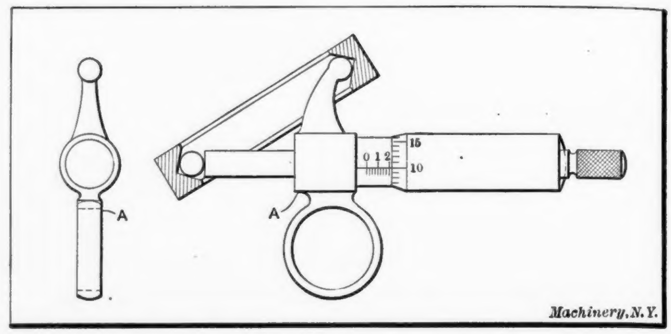


the edge *B*. A piece of sheet metal, bent to the shape *C* with a spring *D* secured to it as shown, is screwed to the under side of the T-square. It is then ready for use.

In operation, the two feet, which are curved at *E* so as not to cut into the wood, bear on the right side of the guide *A*, and the spring keeps the T-square head tight against the left side of the board and relieves the draftsman of the necessity of keeping his left hand on the T-square. This attachment has the additional advantage of preventing the T-square from being knocked to the floor and damaged. F. M.

BALL-RACE GAGE

The accompanying illustration shows a ball-race gage which the readers of MACHINERY will probably find of interest. The main feature is the addition of the machine-steel piece *A* to the ordinary micrometer head. It is made a tight fit, and forced over the micrometer barrel. On the tip of the projecting arm of piece *A*, and of the micrometer stem, ¼-inch steel balls are soft-soldered, as indicated. In use, the posi-

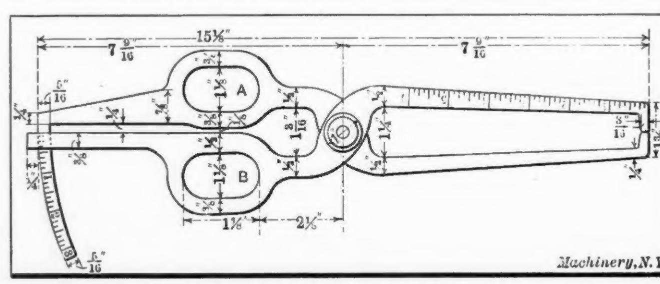


tion of the balls is set by adjusting to an outside micrometer. The reading on the barrel of the gage in this position is noted, and the ball races machined to conform to this reading. The finger-ring on the attachment furnishes a convenient means for holding the micrometer. DAVID MELVILLE

Detroit, Mich.

A COMBINATION CALIPER

The accompanying illustration shows a combination caliper for measuring the interior and exterior of small cored castings, thus enabling one to determine the thickness of the metal and the depth of the core, and also the amount of its eccentricity, if this be necessary. The main feature of this caliper is that it



can be seen at a glance by referring to the caliper graduations what the measurements are, thus obviating the necessity of using a scale in connection with the calipers to obtain the desired measurement. This caliper is so constructed that the operator can hold it with one hand by placing his fingers in the holes *A* and *B* in each of the legs, and can hold the casting with the other, which in some cases is a material advantage.

Bordentown, N. J. EDWARD C. CONLIN

ELIMINATION OF DUST FROM SET-SQUARE EDGES

The method of fixing the edges of a set-square, indicated in the engraving, has been found to be very effective in eliminat-

ing the dirt nuisance on drawings. This treatment of the edges raises the ruling edge against which the pen works, from the tracing, so that the dust on the tracing does not come in contact with it, and hence no blots or ragged lines are formed. BENJ. BROWNSTEIN

Ellwood City, Pa.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

ROCKFORD HORIZONTAL BORING MACHINES

The Rockford Drilling Machine Co., Rockford, Ill., has added to its line of drilling and boring machinery the No. 2 horizontal boring machine illustrated in Fig. 1. The boring-bar and saddle of this machine are vertically adjustable on the column, and the latter has a transverse adjustment on the dovetailed ways of the bed, as shown. Instead of having a rack and pinion to traverse the column, a screw and hand-wheel is employed as the illustration shows. The screw is double-threaded, giving a quick movement to the column, and its application in place of a rack and pinion makes it possible to easily apply power feed for the transverse movement, if necessary.

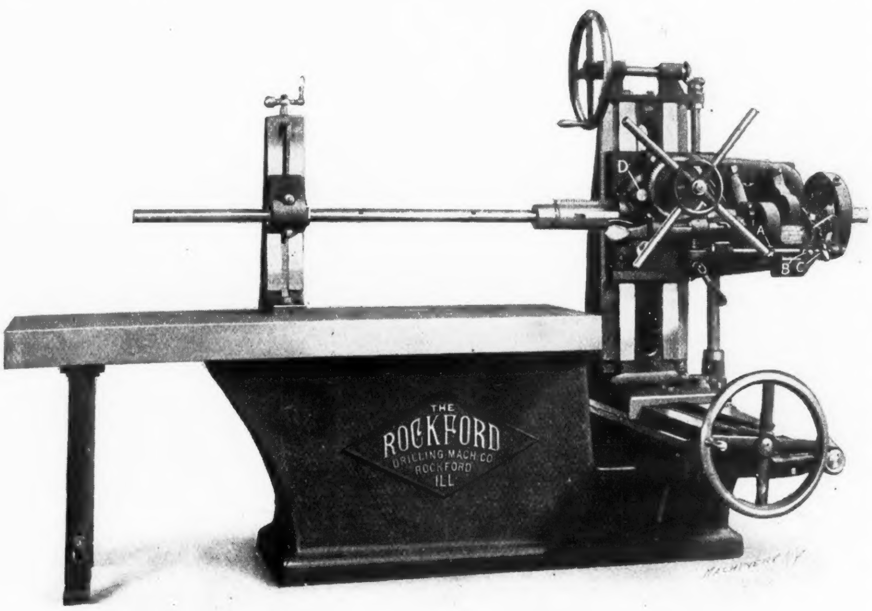


Fig. 1. Rockford No. 2 Horizontal Boring Machine

The table of this machine is solidly supported by the bed, and the projecting end is provided with a bracket to prevent any possibility of springing. This machine is driven by a belt, operating on a four-step back-geared cone, giving eight speed changes. The power is transmitted through bevel gears to a vertical shaft, which connects by bevel gears with an intermediate shaft carrying a pinion that meshes with the large spur gear seen near the end of the boring-bar.

A positive geared feed is used, similar in principle to the feeding mechanism illustrated in the June number, applied to a Rockford 26-inch upright drill, but the construction is somewhat different. The feeding movement is taken from the spindle and it is transmitted to the worm-gearing shown through a gear-box located at the right of the saddle. This box contains a cone of four gears and a tumbler gear mechanism operated by lever *C*. When a change of feed is desired, lever *C* is lowered and the cone of gears is shifted axially by handle *B*, which also moves the tumbler lever index-plate. Lever *C* is then raised and latched, thus bringing the tumbler gears into proper mesh. In this way four feed changes are obtained and this number is doubled by two sliding gears at the left which make connection with the worm driving shaft and are shifted by knob *A*. The amount of feed in thousandths of an inch per revolution of the spindle is shown for different positions of the feed change gears by a pointer and suitable figures. The large star handle is used for traversing the spindle rapidly in or out.

The feeding mechanism has a simple but effective automatic tripping device at *D* for disengaging the feed at any predetermined point. On the threaded hub of the spur gear shown, which is mounted on the pinion feeding shaft, there is a stop-nut which advances toward the face of the gear when the spindle is feeding. Passing through this stop-nut there is an adjustable screw, and when this screw strikes the face of the gear, a lug on the lower part of the stop-nut disengages the trip handle and causes the feeding worm to drop down out of mesh. The principal feature of this stop is that while its range covers the full travel of the sleeve, it operates without the use of trip dogs on the sleeve.

A modification of the machine illustrated in Fig. 1 is shown in Fig. 2. This is a double-ended type that is particularly adapted for boring the crankshaft bearings of gasoline engines of the type now used extensively on farms or for domestic power purposes. The illustration shows a small gas engine cylinder and bed in position for boring the crankshaft bearings. The two boring-heads or columns of this machine are rigidly held together by a tie-bar extending across the top from one to the other. The heads are not adjustable on the bed, as with the single-ended type, there being simply a vertical adjustment for the saddle. The boring-bars are

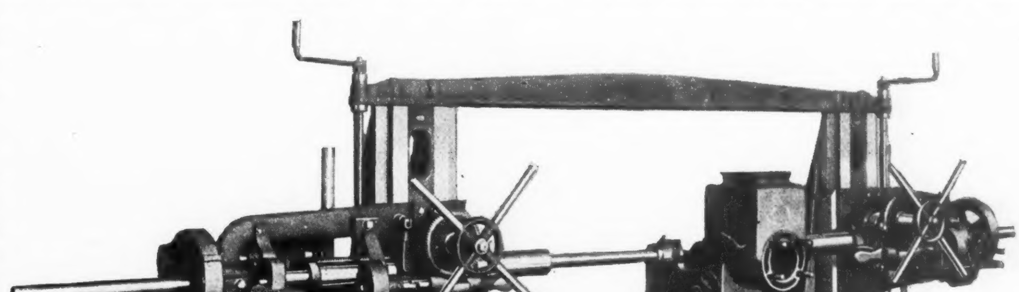


Fig. 2. Double-ended Rockford Boring Machine

accurately located vertically for boring the bearings of different sized engines, by special index-plates that are attached to the saddles. These plates, one of which is shown to the right, contain a number of holes and there is a second series of holes in the column so that the saddles can be positively located by the insertion of accurately fitted plugs.

Some engine cylinders require tapping operations on the upper part of the casting, and for work of this kind a regular sliding-head drill press, with the arm and the table omitted,

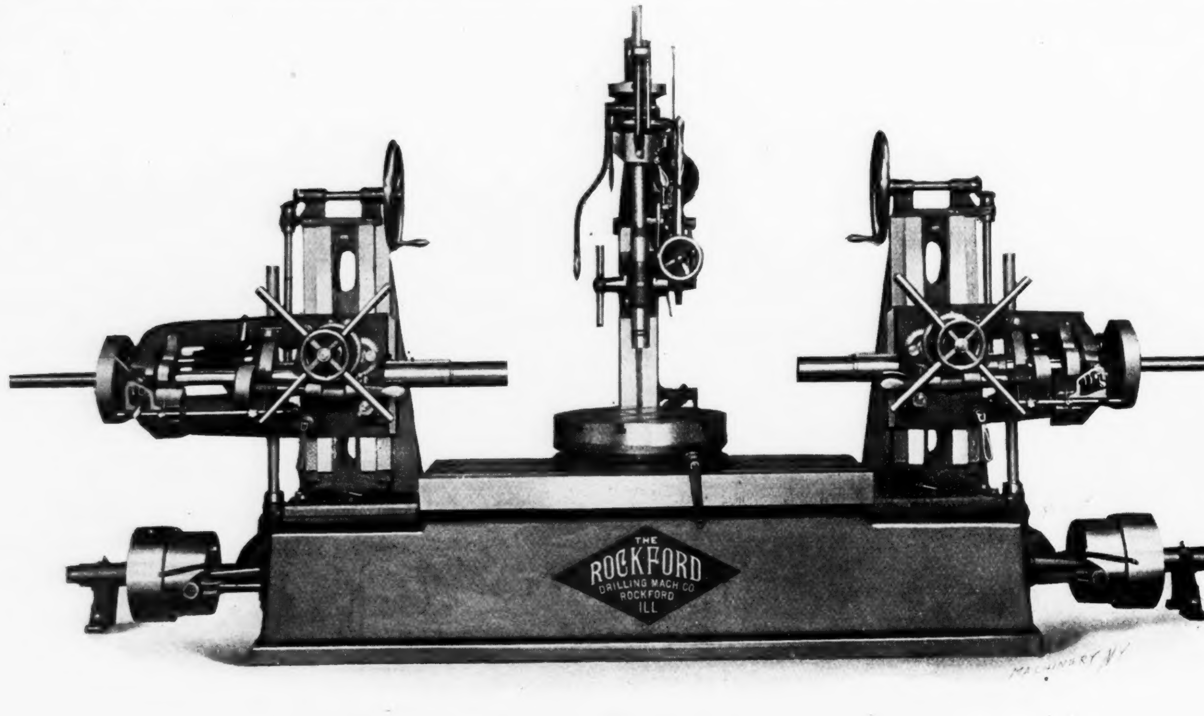


Fig. 3. Boring Machine with Drill Press for Drilling and Tapping Operations

is placed at the rear of the machine, as shown in Fig. 3. The base of the drill press projects beneath the base of the horizontal machine, and a rotary table can be placed upon the table of the horizontal machine for holding the jig containing the gas engine casting. The spindle of the drill press is equipped with a geared tapper, as the illustration shows. In some cases instead of placing an upright drill press at the rear of the horizontal machine, a regular gang drill head of suitable size is mounted on a sub-base which forms a part of the base of the horizontal machine.

The saddles and feeding mechanism of these double-ended machines are similar to the single-ended type. The drive, however, is slightly changed, there being a two-step back-geared cone with a six-inch belt width, instead of a four-step cone, to obtain the extra power required for gas engine work. With this arrangement, eight driving speeds are obtained by the use of a two-speed countershaft. The table of the machines illustrated is 72 inches long by 24 inches wide, but these dimensions can be varied to suit individual requirements.

CUTTING HINDLEY WORM-GEARING ON S. & S. GEAR-HOBBING MACHINE

An interesting experiment has recently been performed on the Schuchardt & Schutte gear-hobbing machine to determine the adaptability of this machine for producing Hindley worm-gearing, and the results are said to be very satisfactory. As will be recalled by those familiar with this machine, the work-table is adjustable horizontally along the bed, and the slide carrying the hob moves vertically on the ways of an upright column. When turning a Hindley worm, the blank is fastened to the hob arbor in place of the hob ordinarily used for cutting spur, worm or spiral gears, and the threads of the worm are formed by a single-point form tool that is clamped on the rotating work-table. During this turning or threading operation, the table is slowly fed toward the worm blank just as it would be for hobbing ordinary worm-gears.

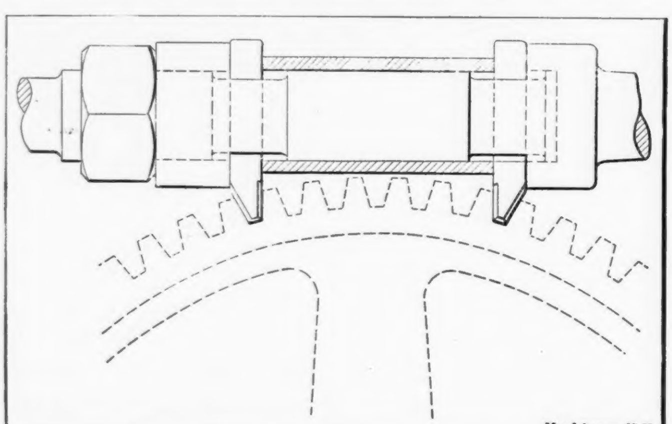


Fig. 1. Showing Double Fly-cutter used for Cutting Teeth in Hindley Worm-wheels on S. & S. Hobbing Machine

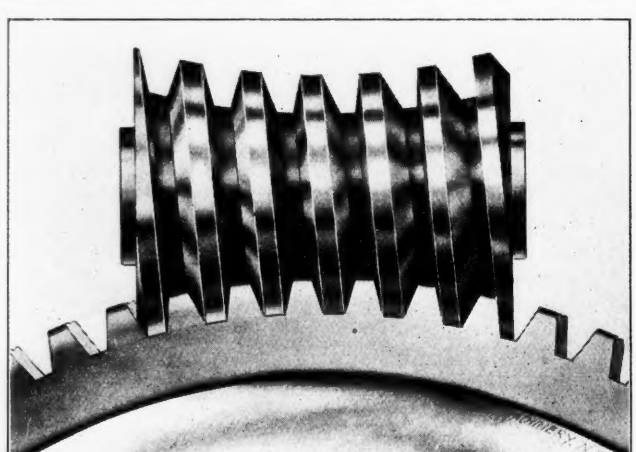


Fig. 2. Typical Hindley Worm and Worm-wheel cut on S. & S. Hobbing Machine

It will be seen that the tool is given a circular movement about a center which corresponds to that of the axis of the worm-wheel. The distance from the tool point to the center of the table is approximately equivalent to the radius of the worm-wheel, and the cutting edge of the tool lies in the same plane as the axis of the worm. The tool and worm blank are geared to rotate in the required ratio, the regular change gears of the machine being used. The tool is given a circular movement equal to the circular pitch of the wheel for each revolution of the worm blank. As the longitudinal curvature of a Hindley worm depends on the diameter of the

particular wheel for which it is intended, the distance from the tool point to the center of the work-table is varied according to the diameter of the wheel.

For cutting the worm-gear, the blank is mounted on the table by means of the supports regularly furnished with this machine, and a special arbor having two cutters, as shown in Fig. 1, are inserted in the cutter spindle. The gear is then finished by the ordinary method employed for hobbing worm-wheels; that is, by gradually feeding the table and work in until the proper depth of cut or tooth is obtained. During this operation, the work-table and cutter spindle are also connected through gearing in the same ratio as when turning the worm. In this case, however, the work is held on the table and the cutters are mounted on the cutter arbor, whereas this order was reversed for turning the worm. As the illustration shows, the cutters are placed in positions corresponding to the end threads of the worm, and as it is these end threads on a hob which give the teeth their final shape (see "The Hindley Worm and Gear," December, 1908) when the hobbing process is employed, these fly-cutters should give satisfactory results provided they are correctly formed and accurately set; in fact, the results obtained by employing the foregoing method in connection with a regular Schuchardt & Schutte gear-cutting machine, are said to be entirely satisfactory. This fact is of especial interest in view of the tests being made at the present time by automobile concerns in the use of Hindley worm-gearing for the driving mechanism, and the simplicity of the process, combined with the fact that very little special tool equipment is required, makes the experiments and their results of considerable value.

Fig. 2 shows a typical Hindley worm and gear that can be cut in the manner just described on the "S & S" hobbing machine sold by Schuchardt & Schutte, Cedar and West Sts., New York.

BARNES DRILL CO.'S TAPPING MACHINES

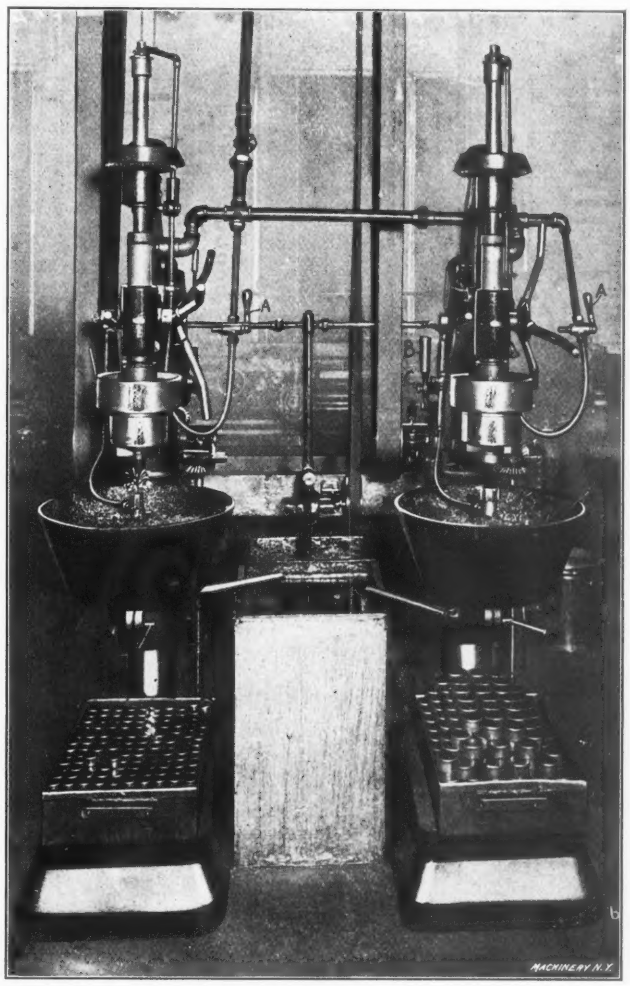
An interesting application of the all-geared tapping machine built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is shown in the accompanying illustration, which is a view of two 20-inch machines specially fitted up for tapping pressed steel grease-cup caps. The spindles of these machines are equipped with Garvin pneumatically operated chucks which grip and release the caps without stopping. The work is fed down on the tap which is held stationary in a special cup-type table that receives the chips and overflow oil. The oil is fed to the work through the center of the tap, as shown in the view of the machine to the left, so that the chips are forced out by the oil and by gravity as well. This has proved to be a very satisfactory method of tapping blind holes.

The compressed air for operating the pneumatic chucks is supplied through the piping shown. Connection is made to each spindle by a flexible metallic hose which permits the necessary vertical movement. This hose is attached to a small pipe leading to the top of the spindle where there is a stuffing-box to prevent the escape of air. From this point the air passes down through a small hole in the spindle to the chuck. The enlarged part of the chuck is an air cylinder containing a piston, the movement of which controls the operation of the chuck jaws.

In operating one of these machines, the work is held beneath the revolving chuck jaws which grip it when air is admitted by turning the hand-valve *A*. Then the work, as before stated, is fed down on the stationary tap until the automatic trip with which these machines are equipped, operates and reverses the motion of the spindle, thus backing the work off the tap at an increased speed. This automatic reverse movement can be set to trip and back out within a quarter-turn from the bottom. The lever *B* which controls the forward and reverse clutch, has a spring-stud *C* that is pulled out for work of this kind, thus allowing the lever to be thrown back instantly into the reversing position when the automatic trip is disengaged. If necessary, however, this lever can be stopped at a neutral position by stud *C*, thus stopping the spindle instead of reversing it. When another cap is inserted in the chuck, lever *B* is pulled forward and latched, thus giving the spindle the forward speed for another tapping operation.

In this particular installation, the lubricant is supplied to both machines from the large tank shown between them. A single pump forces the oil up through the center of each tap as explained. It then drains back to the tank where it is strained before again being used.

It will be noted that the reversing clutch gears are on the driving end of the machine and not on the spindle. As the machine is geared down in the ratio of 13 to 1 in front of the frictions, these clutch gears are located where they have the least to do, and in this way excessive wear is eliminated. These machines are similar in construction to the regular all-geared drill manufactured by the Barnes Drill Co., which has previously been described in MACHINERY (see descriptive articles published May, 1908, November, 1909, and July, 1910).



Two Barnes All-geared Tapping Machines equipped with pneumatically operated Chucks

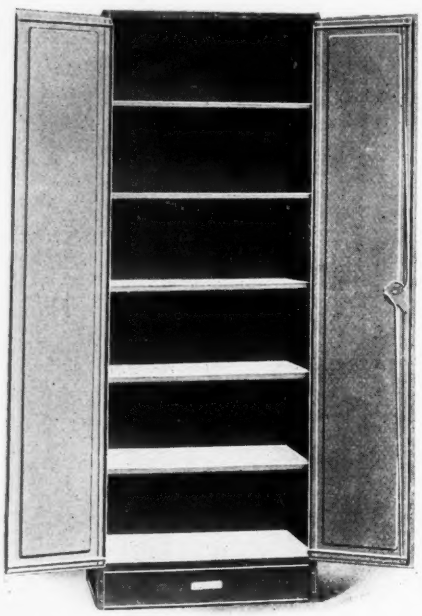
The transmission gears are located on diagonal shafts at the rear, and there are four changes of speed without back-gears, any one of which can be quickly obtained without stopping the machine, by operating conveniently located shifting levers. The star-wheel lever for hand feeding is so arranged as to give a powerful leverage and it also acts as a quick return lever. The movement is transmitted through a pinion running into an internal gear which is mounted on the cross spindle, thus making each handle of the star wheel equivalent to a lever four times its length. The spindles of these machines are made of best quality machinery steel and they are double splined and ground to size. The end thrust is taken by special ball thrust bearings and the nose of the spindle is extended to bring the drift hole below the sleeve.

TERRELL'S STEEL SHOP CUPBOARD

The use of steel cupboards in machine shops and other manufacturing establishments is strongly recommended by insurance underwriters, because they add greatly to the fire

protection of the building. It is especially important that articles of a very combustible nature be stored in receptacles made of fireproof material, as a building is not sufficiently protected when inflammable material is kept on exposed shelves.

A style of steel cupboard for shop use that is now being manufactured by Terrell's Equipment Co., North Grand Rapids, Mich., is shown herewith. The doors of this cupboard are fitted with a three-way locking device, which secures them at the top, bottom and center. If desired, the doors are provided with louver vents or round perforations. The body of the cupboard is made of No. 18 gage special furniture steel, and the doors are made of No. 16 gage steel of the same quality. The frames of both the bodies and doors are reinforced by special steel angles, thus insuring strength and rigidity.

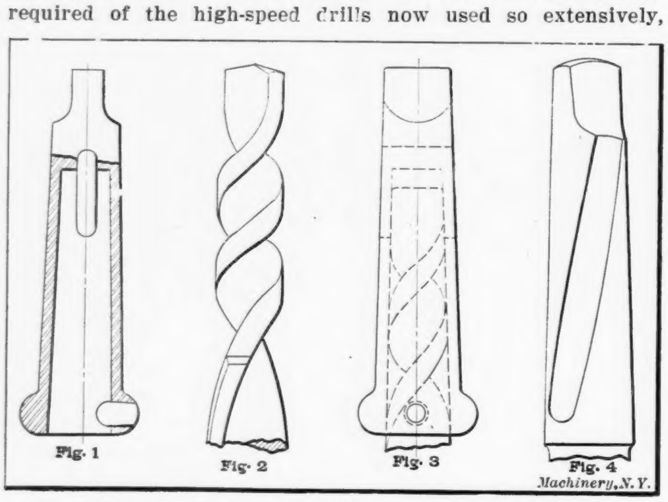


Steel Shop Cupboard, built by Terrell's Equipment Co.

These cupboards are made in the following standard sizes: 30 inches wide by 15 inches deep by 60 or 72 inches high; 30 inches wide by 18 inches deep by 60 or 72 inches high, and 30 inches wide by 24 inches deep by 60 or 72 inches high. The number of shelves can be varied according to requirements, and the cupboards are finished with baked enamel in either olive green, maroon or black. These cupboards will also prove useful for the storage of supplies which are liable to be damaged when stored on exposed shelves. As a building is not strictly fireproof unless the equipment is also made of fireproof material, the use of steel fixtures is certainly to be recommended.

PRATT & WHITNEY HIGH-POWER DRILL SOCKET

Before the introduction of high-speed steel, the service required of twist drills was such that the tang was strong enough to drive a drill in ordinary work, but the heavy duty required of the high-speed drills now used so extensively,



Pratt & Whitney Drill Socket and Shanks for which it is adapted

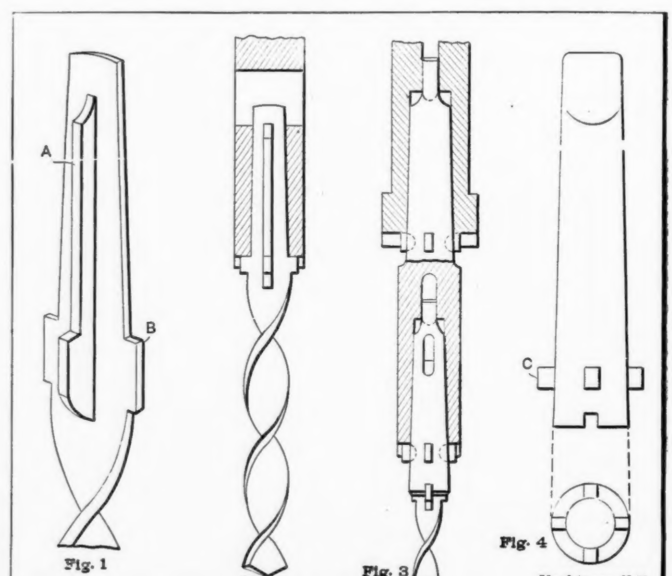
necessitates a stronger drive than that given by the tang, to secure the full efficiency of the drill. Any other method of driving drills should, however, as far as possible, not interfere with the simple collet system which is in universal use at the present time.

Fig. 1 of the accompanying illustration shows a socket brought out by the Pratt & Whitney Co., Hartford, Conn., that is provided with means for driving the "high-power" twisted drill, Fig. 2, or the solid-shank milled drill, Fig. 4, with equal efficiency, and it entirely eliminates the tang drive. This socket is enlarged at the lower end which contains a rounded projecting stud that engages the drill and gives a powerful drive at the base of the shank. The way the high-powered twisted drill is driven is indicated in Fig. 3, and a solid-shank drill having a spiral flute, as in Fig. 4, can also be used in this new socket as well as in one of the ordinary type. It will be seen that when the load is put upon the drill, the ball stud acts as a nut and the shank is thus seated firmly in the socket. The load is distributed between the friction and the stud and the drive is positive. Both types of drills can readily be removed from this socket by the use of center keys in the usual way. This company is prepared to furnish the high-power twisted drill or the high-speed milled drill for use in this new type of socket.

DRIVE FOR TWIST DRILLS

A method of driving twist drills, chucks, collets, etc., has been developed by J. L. Osgood, 121 Erie County Bank Building, Buffalo, N. Y. With this new system, a chuck or drill is driven by wings or projections located at the base or large end of the shank, thus giving a powerful drive.

The principle of the drive is clearly shown by the accompanying illustration. The drill used is formed from flat stock and the shank end is left straight. On this straight part there are strips *A*, Fig. 1, located centrally and on opposite sides to form the drill shank which is machined to a standard



Figs. 1 to 4. Method of driving Twist Drills, Collets, etc., by Wings or Projections at the Base of the Shank

taper. These side strips do not extend to the end of the shank, which forms a flat driving tang to supplement the drive at the large end. If desired, however, the end tang can be dispensed with and the driving projections used alone. These main projections, which are shown at *B*, fit into corresponding slots cut in the spindle, as indicated in Fig. 2.

When the use of sockets or sleeves is necessary, these are also provided with driving projections and cross slots at the ends, as shown in Fig. 3. Thus a drill can be held in either the spindle, a socket or a sleeve, depending on the size of the drill shank, and the same kind of interlocking drive is provided between the drill, sleeve, socket, and spindle. When sockets and sleeves are especially made for this new type of drive, the driving projections *C*, Fig. 4, are made integral, but when it is desired to use old sockets or sleeves, projections are formed by driving separate pieces into keyseats. These keyseats, as well as the slots in the ends of the spindles and sockets, can readily be milled at small cost.

The driving projections on the sleeves and sockets are preferable, but in case these are dispensed with, it would only be

necessary to mill slots for the reception of the drill itself. The side and end view, Fig. 4, of one of these sockets shows the driving projections and the end slots for receiving the sleeve or drill projections, as the case may be. By having the driving connection between the socket and drill at the base of the shank, as with this system, a very strong and reliable drive is insured.

QUEEN CITY BACK-GEARED SHAPER

The latest design of 16-inch back-geared crank shaper built by the Queen City Machine Tool Co., Cincinnati, O., is shown in Fig. 1. This machine is similar in many respects to designs formerly manufactured by this company, but it contains some interesting new features, among which may be mentioned the improvement in the radial bearings.

The bearings of a crank shaper that have to do with delivering the driving power to the ram, are, in the order of their importance, the crankpin, bull-wheel, driving and driven shaft bearings, the lower rocker-arm shaft bearing, and those that connect the link to the rocker-arm and ram. In this machine, these all have heat-treated and ground journals which run in cast iron. As the crankpin has the heaviest duty to perform, in proportion to its size, the body is a crucible steel casting with a heat-treated sleeve pressed over the pin which is ground to a running fit in the cast-iron crank-block. This block has an oil reservoir with channels cut in it to insure thorough distribution of the lubricant, which is lifted from the reservoir onto the crankpin by a chain. This oil flows back to the reservoir, thus having a continuous flow. Means are provided for drawing off the oil and replacing it when necessary.

The hub of the bull-wheel also has a hardened sleeve pressed over it which is afterward ground to size, and it is

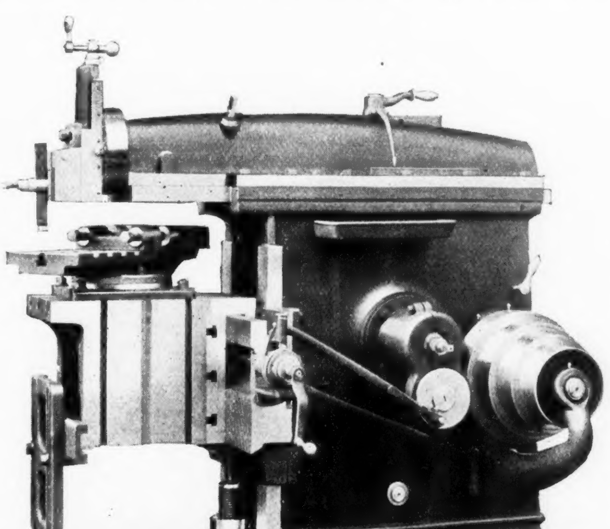


Fig. 1. Queen City 16-inch Back-geared Crank Shaper

oiled by the same method employed for the crankpin. The five journals of the driving and driven shafts are heat-treated and ground, and run in removable cast-iron bushings. These are kept flooded by means of ring oilers. Chains are used on the crankpin and bull-wheel hub and other revolving bearings in the feed, because a ring will not lift sufficient oil when the shaper is running at a slow speed. Fig. 2 illustrates the general construction of these bearings. The rocker-arm and link shafts are also provided with good lubricating facilities, although neither the ring nor the chain can be used, because the motion is not fully rotary, only about one-fourth of a circle being described. The cone-pulley shaft has a three-point bearing, thus eliminating the overhang at the drive.

There are twelve changes of feed on this machine and eight speed variations, which can be so combined as to insure efficient operation. The single-gear ratio of the drive is 4 to 1, and the back-gear ratio, 19 to 1. This combination gives the following cutting strokes to the ram: 7.98, 11.78, 17.15, 25.31, 37.9, 55.95, 81.46, and 120.24 feet per minute, which it will be noted are in geometrical progression.

The workmanship and rigidity of this shaper can be judged by the accuracy guaranteed. The makers agree to produce work within 0.0005 inch for the full 16-inch stroke, and the vise is square within this limit. The arch type of ram is an important factor in securing the rigidity necessary to produce such accurate results, and the table support, as well as the rigid construction of the column, rail, etc., enables the work to be held in a fixed position while being machined.

The shaper is designed very low to make its operation more convenient. The bearing in the column for the ram is long,

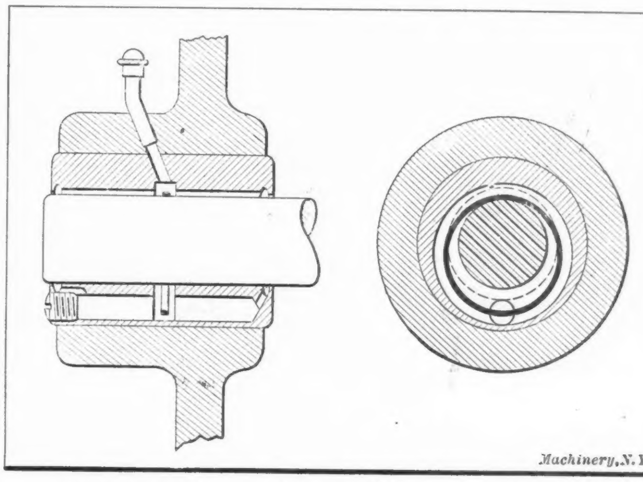
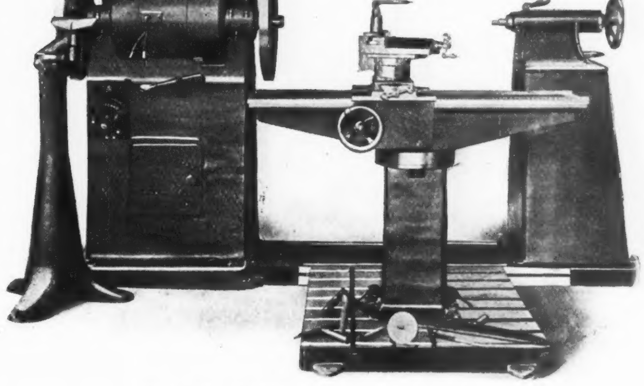


Fig. 2. Detail View showing General Construction of Bearings of Queen City Shaper

as is the ram itself. All flat bearing surfaces are of a large area and gibbed for taking up wear. The feed-screws have micrometer adjustment, and the swivels are graduated. The pinions are made from bar steel, and all gear teeth are generated. This shaper can also be furnished with an all-gear drive and with either a variable- or constant-speed motor drive, in addition to various special attachments.

FAY & SCOTT PATTERNMAKER'S LATHE

A special patternmakers' lathe is illustrated herewith, which has a swing of 100 inches over the baseplate. This lathe is driven by a four-horsepower, Reliance, variable-speed motor, and the headstock is double back-geared. The back-gears are thrown in or out of mesh by means of the handle shown over the motor, and the sliding back-gear is shifted by a conveniently located lever in front of the headstock. The motor



Fay & Scott 100-inch Patternmakers' Lathe

and all the gears are carefully guarded. The minimum and maximum spindle speeds are 22 and 1100 revolutions per minute, respectively. Practically all noise is eliminated in the drive by the use of rawhide pinions meshing with cast-iron gears. Work seven feet in length can be turned between the centers in this particular lathe, which has a 13-foot bed.

The tailstock is adjusted by means of a rack and pinion located at the rear. The absence of all vibration at high speeds is assured by the rigid construction and perfect balance of all rotating parts. This machine is the product of Fay & Scott, Dexter, Me.

GARVIN NO. 22 PLAIN MILLING MACHINE

The milling machine illustrated in Figs. 1 and 2 was designed by the Garvin Machine Co., Spring & Varick Sts., New York, primarily for manufacturing purposes. It is a powerful machine of large capacity having a minimum number of parts which are constructed to withstand hard and continuous work.

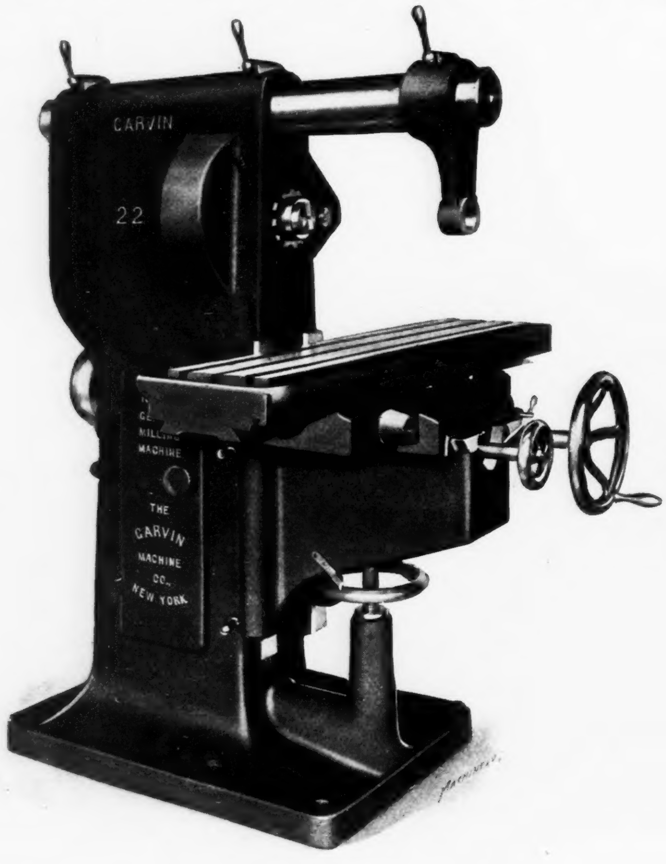


Fig. 1. No. 22 Plain Milling Machine, built by Garvin Machine Co.

Fig. 2. View of Garvin Machine from Opposite Side

By referring to Fig. 1 it will be seen that one side of the machine is closed or solid, thus joining the arm and spindle bearings rigidly together and to the body of the machine. This construction insures great rigidity and freedom from vibration. The drive to the spindle is from a three-step cone-pulley at the side, which transmits the power through gearing having a ratio oi $5\frac{1}{4}$ to 1. The general arrangement of the drive is shown in the sectional view, Fig. 3. The cone-pulley takes a four-inch belt and has a maximum diameter of twelve inches. The spindle has a No. 11 B. & S. taper hole with a driving slot, and it runs in adjustable bronze boxes as shown in the illustration.

The feed is driven either from the spindle or the cone-pulley shaft, the change being effected by operating handle *H*, which controls the position of gear *C* mounted eccentrically at its end. When gear *C* is in mesh with gear *A* of the spindle, a slow feed is obtained, and when it is thrown into mesh with gear *B*, which rotates at a higher speed, there is a corresponding increase in feed. The feeding movement is transmitted from either gear *A* or *B*, depending on which of these gears is in mesh, through *C* to the pinion *E*, which drives gear *D* and the belt pulley *F*. This pulley, in turn, is connected by a wide belt with the feed shaft at the side of the column, which extends forward to the table. The feeds vary from 1/200 to 1/4 inch per revolution of the spindle, change gears being provided to cover this range.

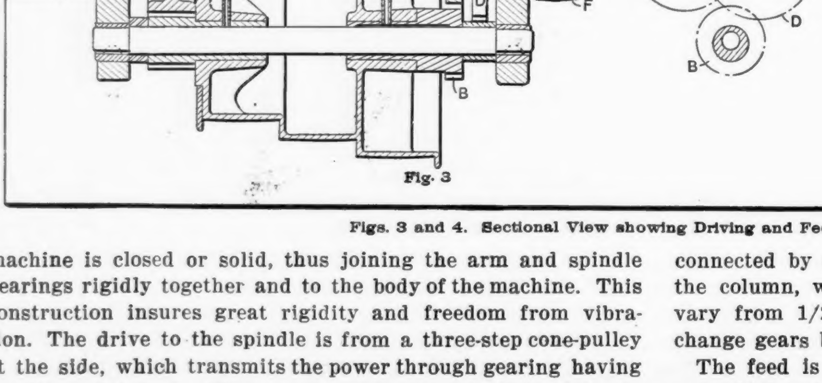


Fig. 3

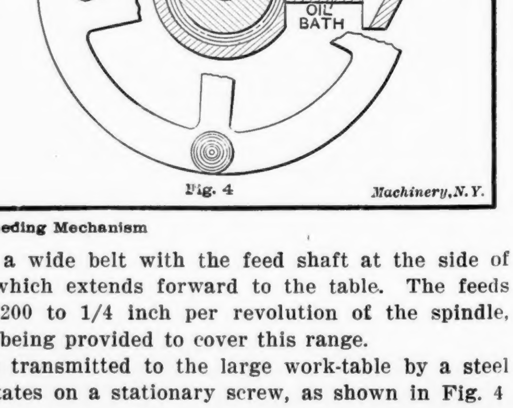


Fig. 4

Machinery, N.Y.

Figs. 3 and 4. Sectional View showing Driving and Feeding Mechanism

The feed is transmitted to the large work-table by a steel nut which rotates on a stationary screw, as shown in Fig. 4

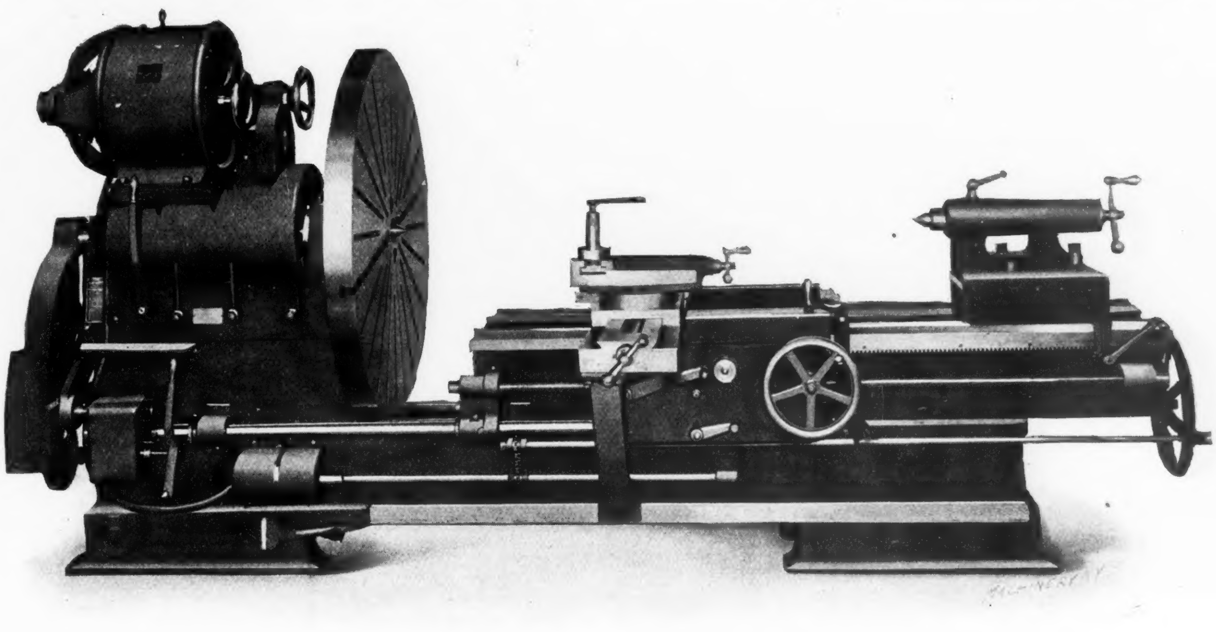
The rotary feed nut is directly driven by a hardened steel worm-gear and worm running in oil. The large handwheel shown, which connects with the rotary nut through spiral gears running in oil, is for feeding the table by hand. The feed-box is built into the saddle so that the stresses are taken in the most direct manner and the number of joints is reduced to the minimum. The saddle is massive, and has a micrometer adjustment. The knee is of the Garvin closed-top construction, and it is adjusted vertically by a micrometer handwheel and screw which does not pass through the floor. The overhanging arm is exceptionally large, and the braces connect the saddle and arm, leaving the yoke free to be adjusted to suit the arbor and position of the cutter. All gears are protected as the illustrations show. The weight of this machine is 3050 pounds.

RAHN-LARMON GAP LATHE

The Rahn-Larmon Co., Cincinnati, O., is the manufacturer of the electrically-driven gap lathe shown in the accompanying illustration. This type of lathe is also built with a belt drive. As the gap lathe is particularly adapted for repair shops, the electrically-driven machine is often very desirable, aside from the advantages inherent to the motor drive, in and it has a long continuous bearing on the bed. When using the cross-feed, the carriage can be firmly locked, and it is so arranged that the tool-rest can be brought close up to the gap when necessary. The front of the carriage has an extension which is firmly braced, as shown, thus allowing extra travel for the tool-rest in order that the tool may operate on the largest diameter that can be swung in the gap. The apron is of simple design and all the gears, as well as the rack, are made of steel, while the stud pins are hardened and ground.

A large range of both longitudinal and cross feeds is obtained by shifting the change-gear lever attached to the feed-box, and the feeds are so arranged that no two can be thrown into operation simultaneously. A safety device also prevents the breaking of the feed-box gears, or those in the apron, either because of accident or carelessness. The screws for the compound rest and cross-feeds have graduated micrometer disks.

The equipment regularly furnished with this lathe includes a countershaft, steadyrest, follow-rest, large and small faceplates, wrenches and a full set of change gears. Additional equipment, which can be furnished extra, consists of a taper attachment, extension turning rest, turret on the carriage, chucks, turning tools, faceplate chuck, or any special tool-



Electrically-driven Gap Lathe, built by Rahn-Larmon Co.

that it enables the lathe to be located in an isolated part of the shop, or where the transmission of power by a shaft and belt would be impracticable.

The motor is attached to this lathe so as to conform with the general design, and power is transmitted directly to the spindle through gearing. The motor is mounted as close to the spindle as possible, to eliminate vibration at high speed. The entire headstock and the change gears are covered, thus protecting the operator. The starting and stopping of the motor is controlled by a lever mounted on the right side of the apron and within convenient reach. This lathe can be equipped with either a constant- or a variable-speed type of motor.

The design of the lathe in general is such as to insure a rigid machine of simple construction. The top or extension bed can be adjusted to any width of gap within the range of the lathe, by means of a handwheel which operates a screw of coarse pitch. Of course, this adjustment also greatly increases the maximum distance between the centers. Both the main and top beds are very heavy, and the latter is accurately planed and fitted, thus insuring accuracy of alignment between the spindles and carriage for all positions. The spindle is hollow and is made of a special carbon steel. The boxes are made of the best gun metal and they are provided with means for taking up wear.

The carriage is gibbed to the bed both in front and back, rest. This lathe has a swing of 24 inches when in the closed position, and a swing of 48 inches through the gap.

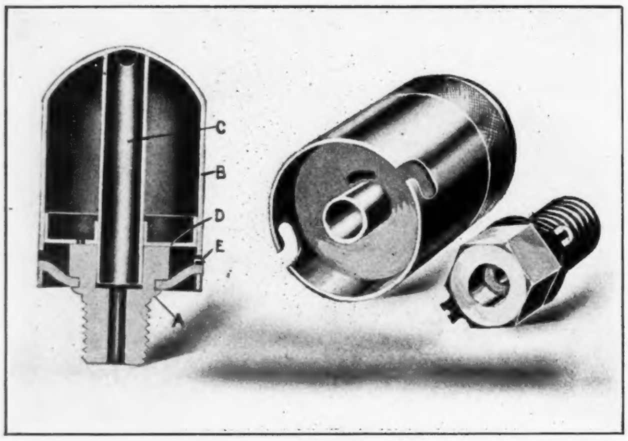
TWENTIETH CENTURY LOOSE-PULLEY OIL CUP

The oil cup illustrated herewith is designed to automatically oil loose pulleys without using any more lubricant than is needed to keep the bearing in good condition. The cup after being filled will run from one to three weeks, the time depending on the number of starts and stops, speed, etc., and all the oil put into the cup goes to the bearing, but the feed is so regulated as to eliminate waste by flooding.

The oil is fed from the cup *B* to the central feeding tube *C* by centrifugal force, the operation being automatic. When the pulley is started, the centrifugal force caused by the rotation carries the lubricant to the top of the cup and into the tube which is provided with small apertures as shown in the sectional view. This tube serves as a measuring device for the charge of oil to be delivered to the bearing. The two or three slow rotations accompanying the starting and stopping of the pulley, cause the tube to be filled and a part of its contents to be discharged to the bearing. In this way sufficient oil is delivered to keep the bearing well lubricated.

The view to the right shows how the cup is detached from the threaded nipple, which is screwed in the loose pulley,

when it is necessary to refill it. The cup *B* is first removed by hand and it is then filled through the central feed pipe *C*. Small vent holes are provided at *D* to allow the air to escape. The cup is easily replaced on the nipple by slightly rotating it so as to engage springs *E*, which enter the slots shown,



Automatic Loose-pulley Oil Cup

thus locking the cup in place. This filling operation can be performed with the pulley in any position, thus doing away with the necessity of shifting the belts or turning the shaft to bring the oil hole at the top.

This cup is made of thin pressed steel and it is so light that counterbalancing is unnecessary. It is, however, strong and there are no moving or wearing parts. The American Specialty Co., 834 Monadnock Building, Chicago, Ill., is the manufacturer.

FAY & SCOTT CENTERING MACHINE

Fay & Scott, Dexter, Me., are the builders of the double-end centering machine shown in Fig. 1. The bed of this machine is a standard lathe bed type and there are two centering heads as shown. The left-hand head is stationary and the one to the right is adjustable along the entire length of the bed. This adjustment is effected by a handwheel which operates through a rack and pinion. The two centering heads are pivoted so that by tilting them slightly, either the drill or the countersink can be brought into the centering position or in alignment with the center of the work. The spindles are fed in or out by hand levers which connect with the spindles by means of a rack and pinion.

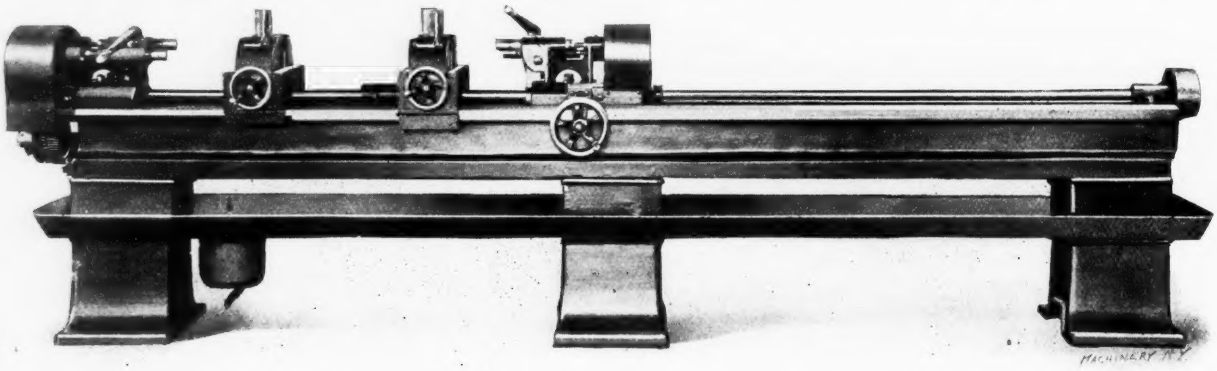


Fig. 1. Fay & Scott Double-end Centering Machine

The construction of the stationary head to the left, is clearly shown in Fig. 2, which is a detail view with the protective covering removed. This view also shows the two chucks in which the work to be centered is held. These are of the self-centering type and have jaws of hardened steel that are operated simultaneously by means of right- and left-hand screws. The position of these chucks on the bed can be varied according to the length of the work. The driving mechanism for the spindle consists of a shaft extending the entire length of the machine. This shaft is driven by a belt, and connection is made with the spindles by silent chains. The spindles are made of hammered steel and are provided with renewable bronze bearings.

The countershaft furnished with this machine has tight and loose pulleys and double-brace self-oiling hangers. Special fixtures for holding work of any kind can also be supplied. The principal dimensions of this machine are as follows: Maximum swing over bed, 18 inches; maximum distance between drills (10-foot bed), 60 inches; taper of spindles, No. 2 Morse; speeds of drill and countersink spindles, 425 and 250 revolutions per minute, respectively; size of

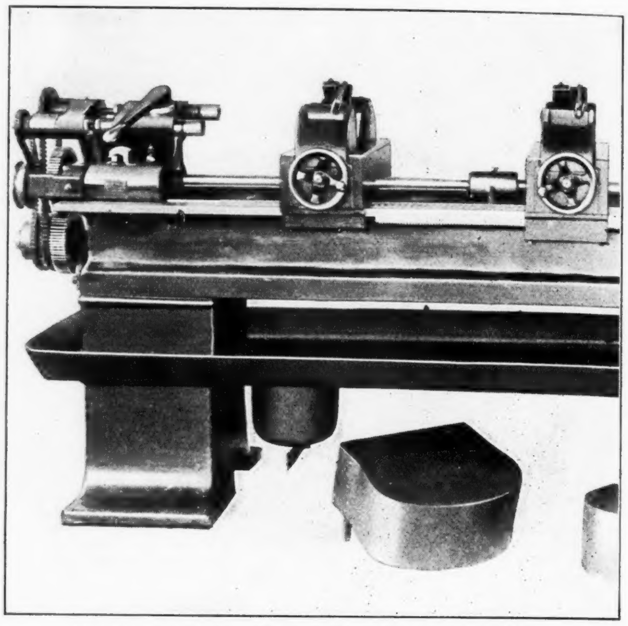


Fig. 2. Detail View of Fay & Scott Centering Machine

spindle bearings, 1¼ inch by 9 inches; maximum capacity of chucks, 6 inches. The weight of the 10-foot machine is 3500 pounds, and the weight per foot of bed is 100 pounds.

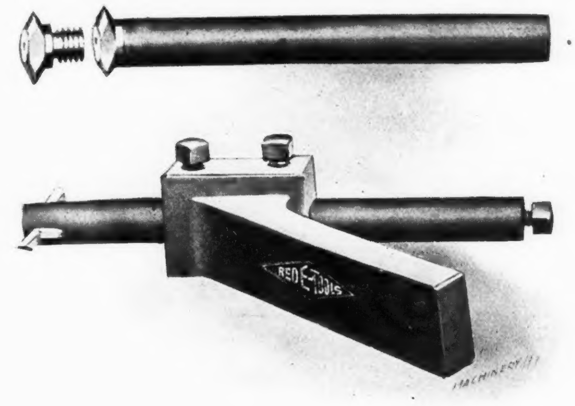
BORING AND INTERNAL THREADING TOOL

A boring-bar and internal threading tool that has just been placed on the market by the Ready Tool Co., Bridgeport, Conn., is shown in the accompanying view. The cutter of the boring tool is held in place by a set-screw in the end of the bar, which forces a rod, extending through the bar, up against a sliding wedge that securely holds the cutter against all movement. When it is necessary to sharpen the cutter, the set-screw in the end is loosened, which releases the wedge and permits the cutter to be taken out. When the sharpened cutter is again placed in the holder, it is located at the same height as before, without the necessity of adjustment.

The bar is rigidly held in the holder by a sliding dog which is forced down by the two set-screws shown; the dog avoids marring the bar and holds it rigidly. This method of clamping also provides means of adjustment so that the bar can

be replaced by a piece of ¾- or ⅝-inch solid steel in case this should be necessary for boring small holes.

In addition to the boring-bar, an internal threading tool is furnished with this holder. This threading tool, which is shown in the upper view, has a circular cutter screwed in

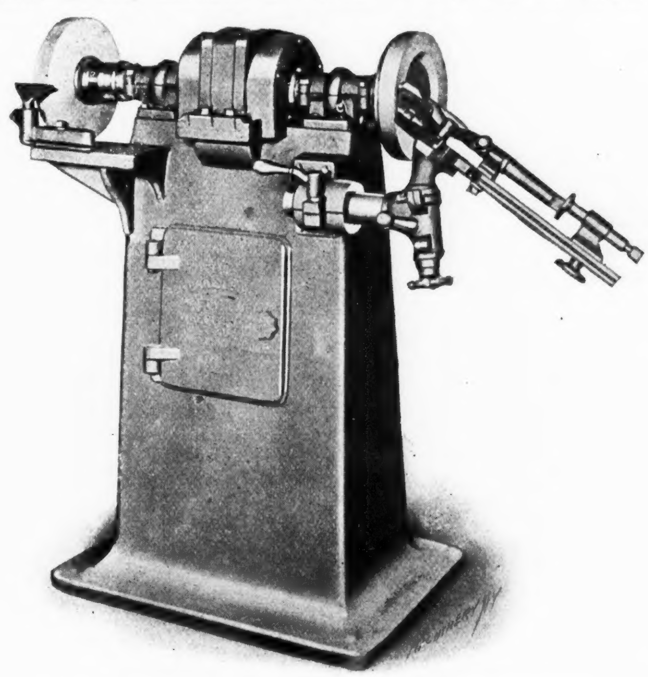


Boring and Internal Threading Tool, manufactured by the Ready Tool Co.

the end that is ground to a 60-degree angle, so that the "one grind" feature, common to the tools made by this company, is applicable in this case. Extra cutters for either the boring or threading tools can be supplied.

MOTOR-DRIVEN COMBINED TWIST DRILL AND DRY GRINDER

The Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., is now building the combination twist drill and dry grinder illustrated herewith. One end of this machine is a plain grinder for doing miscellaneous work, and the other is arranged for grinding twist drills. The grinder is electrically driven by either a direct- or alternating-current motor. The motor is fully enclosed, as shown, to keep out the flying



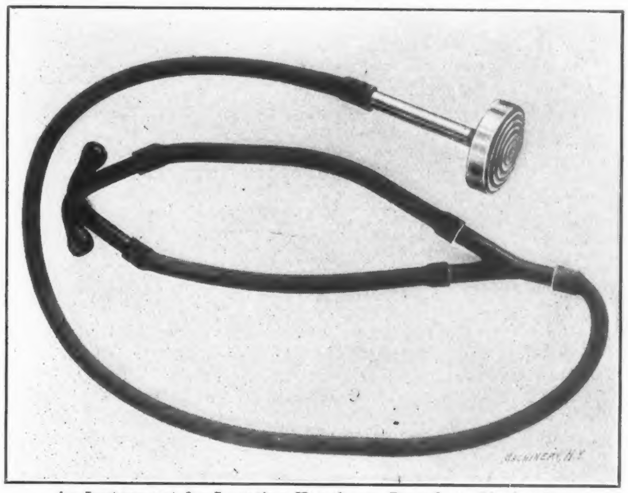
Combined Twist Drill and Dry Grinder, built by Bridgeport Safety Emery Wheel Co.

particles of emery, and the bearings are bolted directly to the base, thus giving a very solid construction. This motor has ample power to drive wheels up to 12 inches in diameter. The bearings are of bronze and ring-oiled. They are extra long, as the illustration shows, and can be renewed if this becomes necessary owing to wear. These bearings have a length of 8 inches and a diameter of 1⅜ inch. The twist drill grinder, which is made by the Washburn Shops, is clamped in a split sleeve bolted to the column. The particular grinder shown is a No. 1 size, but this twist drill grinding attachment can also be applied to the No. ½ and No. 2 machines built by this company.

THE VIBRACATOR OR SOUND INTENSIFIER

The vibracator, as the name implies, is used for detecting "knocks" or excessive vibrations in machinery, due either to wear or defective adjustment, and it is particularly useful for determining the location and probable cause of extraneous noises connected with mechanism that is encased and therefore not visible. This instrument is scientifically designed, and all sounds are greatly intensified by it, so that even very light blows or pounds can easily be located. It has at one end a corrugated hardened steel diaphragm, the vibrations of which are transmitted by the air enclosed in the head, up through the rubber tube shown, to the ears. This diaphragm is only a few thousandths of an inch thick, it being made as thin as possible to draw the metal to the corrugations. The ear tips are held in place, when the instrument is in use, by concealed springs, so that the hands are left free.

This instrument is used by placing the corrugated diaphragm against that part of the machine which seems to be nearest the cause of the trouble. If an encased mechanism



An Instrument for Locating Knocks or Pounds in Mechanism

is being tested, the diaphragm is moved over the exterior surface of the casing until the knocking is centralized or the instrument is located where the sound is greatest. If the construction of the mechanism being tested is known, the probable defect can then be determined. It is very essential that the ear tips be well inserted in the ears, in order to exclude all external sounds, and thus secure the maximum sensitiveness. The vibracator not only enables defects to be located quickly, but its use also often makes it unnecessary to dismantle more than the section that needs repairing. The vibracator is manufactured by Hopewell Bros., Newton, Mass.

NEW MACHINERY AND TOOLS NOTES

Keyseater: John T. Burr & Sons, 429 Kent Ave., Brooklyn, N. Y. Portable shaft keyseater, also adapted for use in the lathe by removing the hand-crank, pinion and pinion stud. The keyseater is placed between the lathe centers and is driven by a driver fastened to the faceplate.

Tapping and Threading Attachment: J. C. Barrett Co., Hartford, Conn. Combined tapping and threading attachment that can readily be applied to lathes. The change for either tapping or threading is made by simply reversing the attachment. It is equipped with an adjustable gage for use on duplicate work.

Swinging-Frame Grinder: Pittsburg Emery Wheel Co., Pittsburg, Pa. Swinging-frame grinding machine adapted for steel and malleable iron foundries, crucible steel plants, etc., for grinding fins and gates from castings or for doing similar work. This grinder is made in two styles, one being driven by a belt from the lineshaft and the other by a motor.

Keyseater: F. L. Schmidt, 11th Ave. & 21st St., New York City. Portable hand-operated keyseater with a capacity for lengths up to 8 inches and a width of ½ inch. On the return stroke the cutter is automatically lifted, and the leverage of the operating handle can be varied according to the size of the keyseat. The machine weighs, complete, 86 pounds.

Polishing Stand: Gardner Machine Co., Beloit, Wis. Polishing stand, the wheels of which are fully enclosed by dust-hoods when in operation. The wheels are made in either 14- or 16-inch sizes, and an abrasive cloth band is stretched over a backing of felt by a device which maintains a constant

tension. The bearings are lubricated with compression grease cups.

Electric Hoist: Euclid Crane & Hoist Co., Euclid, O. Electric hoist having scored hoisting drum with sufficient surface to prevent overwinding; three reductions of spur gears; and a load brake. All the high-speed mechanism runs in a bath of oil, and other bearings are supplied with grease cups. An effective limit attachment prevents the bottom block from going too high because of carelessness.

Surface Grinder: C. G. Garrigus Machine Co., Bristol, Conn. Surface grinder designed for manufacturers using dies for presses, stamps and for other work where surface grinding is required. Beneath one of the two wheels there is an 8- by 15-inch table. This table is adjustable vertically by a handwheel, and it can also be moved up and down the column to any position. The opposite wheel is provided with a tool-rest.

Semi-Automatic Welding Machines: Toledo Electric Welder Co., Langland & Knowlton Sts., Cincinnati, O. Power-driven machine for electrically butt welding wire, in which from fourteen to twenty welds can be made per minute, depending on the size of the stock. The operator places the work between the clamping jaws and removes it after a weld has been completed. All other operations are performed automatically.

Power-driven electric spot welder for welding sheet metal. The operation of this machine is similar to a power punch-press, and it will make from forty to one hundred welds per minute, depending on the thickness of the metal welded. It is operated by a foot-pedal switch that is counterbalanced to stop the machine automatically if necessary.

Shaper: Hendey Machine Co., Torrington, Conn. Motor-driven shaper, with motor mounted on a bracket at the rear which can be rocked to and from the base to secure the proper belt tension. The machine has a friction drive which enables the operator to start or stop it with the motor running; it also provides a quick and easy control that facilitates setting the tool to any desired position. Motors can be furnished for either direct or alternating current.

Cutter Grinder: Northampton Emery Wheel Co., Leeds, Mass. Machine for grinding straight and spiral cutters, side mills, etc. It is provided with an adjustable rest connected with the slide that holds the cutter being ground. This slide has an adjustable stop at the rear to regulate the amount of grinding. The face grinding attachment can be tilted to any angle and also has an adjustable stop for the slide. The mill is held perfectly rigid while being ground, by a plunger that locks into the teeth.

Buffing Lathe: Ransom Mfg. Co., Oshkosh, Wis. Buffing lathe of the type that can be driven from a lineshaft or countershaft beneath the floor, the belt being entirely enclosed. The belt shifter is in the form of a small handle and is conveniently located at the front. One-half turn of this handle serves to shift the belt. The machine has long dustproof ring-oiling babbitted bearings and bearing caps arranged to take up wear. A door is located in the back of the pedestal, thus giving ready access to the belt if necessary.

Cylinder Boring Machine: Barrett Machine Tool Co., Meadville, Pa. Horizontal cylinder boring machine designed for boring and facing, simultaneously, all kinds of cylinders and other cylindrical work within its capacity. The boring-bar has a continuous feed, in either direction, of thirty inches. A quick-change feed-box provides changes of feed varying from 1/32 to 3/8 inch per revolution of the bar. There are two heavy facing arms that can be started and stopped at will. The machine can be furnished for belt or motor drive.

Grinders: Springfield Mfg. Co., Bridgeport, Conn. Rotary surface grinder having a work-table, housings, and cross-rail similar to a vertical boring mill. On the cross-rail two grinding heads are mounted, one being vertical and the other horizontal. The vertical head can be swiveled for grinding angular work, and it is directly driven by an electric motor. Both heads are provided with automatic trips. The speed of the work-table can be changed for various diameters by means of change gears. The table is 45 inches in diameter.

Improved form of Standard No. 4 car-wheel grinder. The bed is very heavy, and the wheel-heads are of an entirely new design. The overhead works are carried on columns attached to the bed. This machine will grind wheels up to 43 inches in diameter.

Cylinder Boring and Reaming Attachment: Garvin Machine Co., Spring & Varick Sts., New York City. Boring, reaming, and lapping attachment applicable to this company's No. 15 plain miller and specially designed for automobile cylinder work. It has an adjustable boring head containing three tools, that is mounted on a special horizontal head bolted solidly to the face of the miller and clamped to the overhanging arm. The regular feed of the table is used as well as the automatic stops. The adjustment of the knee on the column enables the different cylinder holes to be located easily.

Mandrel Press: C. T. Eames Co., Kalamazoo, Mich. Mandrel press so designed that by changing the position of a single pin, a simple or compound leverage may be obtained. When the press is operated by a simple lever, the ram has a movement of 2 inches for each stroke and the force applied at the end of the lever is multiplied 135 times. By engaging a pin and compounding the leverage, the ram stroke is decreased to 3/8 inch and the power is increased five times. The ram is square and is operated by a rack and pinion. The work-table may be adjusted vertically by a hand crank.

Ring Wheel Chuck: Charles H. Besly & Co., Chicago, Ill. Pressed steel ring wheel chuck for holding cylindrical or ring grinding wheels. It is furnished in connection with Besly grinders for roughing off scale and excess stock from work which is too rough to be ground economically with emery cloth disks. The construction of the chuck is such that there are no external projections, thus insuring safety for the operator. The grinding ring is clamped on the circumference only. These chucks are furnished for 10-, 12-, 14-, 15-, 18-, 24- and 30-inch wheels and for various types of grinders.

Hand Tachometer: Schuchardt & Schutte, Cedar & West Sts., New York City. Combined hand tachometer and cut-meter for indicating rotative speeds as well as the cutting speeds of various machine tools. The results are instantly shown on the dial in revolutions per minute and feet per minute without the necessity of calculating or using a watch. Four different speed ranges are provided, which may be selected according to requirements. There is only one spindle for all ranges of speed and adjustments are effected by simply shifting a thumb-slide. This is an accurate, durable and compact instrument.

Radial Drill: Midland Machine Co., Detroit, Mich. Thirty-inch radial drill possessing the advantage of a sensitive machine combined with the productive capacity of the radial type. No gears are employed in the drive or the reversing device, and power is transmitted by a 2-inch belt running at high speed. The spindle runs in dustproof ball bearings and there are six spindle speed changes. The feed is by a long lever having a ratchet device that automatically releases in the upward position. The spindle can be traversed quickly by means of a small handwheel. This machine is compactly built and occupies a small amount of floor space.

Vertical Bench Miller and Drilling Machine: R. M. Clough, Tolland, Conn. Combination vertical bench drilling and milling machine having a capacity for holes up to 1/2 inch and for mills up to 1/2 inch or larger, if necessary. The table has a working surface of 16 by 5 1/8 inches, a longitudinal movement of 10 inches, and a transverse movement of 5 inches. The feed-screws have micrometer dials reading to thousandths of an inch, and the feed can be disengaged at any predetermined point by adjustable stop gages. The spindle sleeve has a movement of 4 inches, and means are provided for clamping the spindle for milling operations.

Milling Machine: E. S. Lea, Lamberton & Lalor Sts., Trenton, N. J. Combination vertical and horizontal milling machine designed for a wide range of work. This machine is of the column and knee type and is radically different from the conventional design. The head may be adjusted to bring the cutter in horizontal and vertical positions or in any intermediate angular position. The head also has an in-and-out adjustment. The drive is by a seven-step cone at the rear engaging a square shaft that transmits power to the cutter spindle through gearing. The table has a working surface of 7 1/2 by 22 inches and vertical range under the spindle up to 17 1/2 inches.

Grinding Machine: Black Rock Machine Co., Bridgeport, Conn. Special grinder intended for grinding tapering plugs or similar parts up to four inches in length. By means of a special headstock it is also adapted for grinding washers up to four inches in diameter. A large cup grinding wheel is used, and the drive is self-contained, no countershaft being required. The rotation of the work and reciprocating motion of the grinding head are controlled by a foot lever. When this lever is released, the carriage always stops with the grinding wheel away from the work. This machine is compact in its construction and is said to be free from any tendency to chatter or vibrate.

Upright Drilling Machine: Frontier Iron Works, Buffalo, N. Y. Twenty-four-inch heavy-duty sliding-head drill press with back-gears, wheel, lever and power feeds, and an automatic stop. The spindle is made of high-carbon steel and it has a quick return. It is operated by a steel rack and pinion and worm-gearing, the worm running in an oil bath. The spindle sleeve has a sliding collar for regulating the automatic stop mechanism. The knee is very heavy and has a long bearing on the column. It is raised and lowered by means of worm-gearing through a rack and pinion. This machine can be equipped with the company's well-known tilting table. It drills to the center of a 24 1/2-inch circle.

Sand Sifter: Arcade Mfg. Co., Freeport, Ill. Machine for riddling sand in the foundry, consisting of two wire-cloth cylinders, one within the other, mounted horizontally in a frame. The respective diameters of the two cylinders are 14 and 24 inches. The sand to be sifted is shoveled into the inner cylinder at one end and both cylinders are rotated either by hand or power. By means of a system of lugs and

rollers the cylinders are jolted four times during each revolution, which disintegrates the lumps and prevents the sand from clogging the screen. The sand passes through the sieve as fast as it is shoveled in and the sieve is tilted slightly, so that foreign matter is discharged through a chute at one end.

Cam Grinding Attachment: Landis Tool Co., Waynesboro, Pa. Attachment designed for grinding cams while in place on their shafts, and adapted to solid shafts having cams integral, or those of the built-up type with detachable cams. It is constructed on the swinging principle, the main table holding the work and master cam, being suspended from bearings at the ends. The work is held between centers, and the master cams are brought in contact with a roller which gives a swinging motion to the table, thus reproducing the cam shapes on the work. This attachment can be used on plain and universal grinders of 12- and 16-inch swing, and it is applied by simply clamping it to the table after removing the head- and foot-stock.

Radial Drill: Kane & Roach, Niagara & Shonnard Sts., Syracuse, N. Y. Radial drilling machine claimed to be one of the largest built in this country. The radius of the arm is 9 feet, work 8 feet high can be placed under the spindle, and the column has an overall height of 14 feet. The arm is raised and lowered by power, and the head also has power feed on the radial arm for use in milling large castings, the machine being adapted to milling, boring, and drilling operations. The control of the machine and the speed variations are effected by manipulating two levers at the left of the head. Four feed changes are available, and the spindle is counterbalanced with a coil spring. The dimensions of the base are 10 by 14 feet, and the approximate weight of the machine is 13 tons.

Accident Preventor: Geuder, Paeschke & Frey Co., St. Paul Ave. & 15th St., Milwaukee, Wis. Safety device for punching, stamping, cutting, embossing and drawing presses, etc. The device consists of a folding gate which extends downward in advance of the punch, thus effectually blocking an approach to the die. As the punch completes its operation, the folding gate instantly moves upward, entirely out of the workman's way. The device is so connected with the clutch-operating lever that it works automatically and does not reduce the output of the press. As the gate is of lattice work, the die is always visible. In case the operator, with his hands or otherwise, interferes with the downward movement of the gate, the clutch pin will not engage and the punch cannot descend. This device can be attached to any style of press without altering the clutch or treadle.

Rotary Magazine: Cleveland Automatic Machine Co., Cleveland, O. Rotary magazine feeding attachment for the Cleveland automatic screw machine, that will handle work having wings and projections of a varying diameter. It consists of a magazine wheel to which are attached bushings that are made to suit the parts to be machined. The work is mounted on these bushings by the operator, who can attend to several machines, and the magazine is indexed for each revolution of the turret, thus bringing the parts successively before a conveyor which removes them from the bushings and conveys them to the machine chuck. One side of the magazine wheel has a series of countersunk holes in which a spring-plunger enters to locate the magazine in the correct position. The conveyor can revolve freely on the spindle, and this rotary movement takes place when the work has been gripped with the chuck and before the conveyor has been withdrawn.

Automatic Grinding Machine: Norton Grinding Co., Worcester, Mass. Grinding machine which operates automatically and is adapted to cylindrical work up to 6 inches in diameter. A magazine feed is used and the work is held, while being ground, between two plungers which locate it in a central position. Provision is made for changing the plunger end to suit various classes of work. The work is rotated while being ground, through a four-speed gear-box mounted on the carriage. The movement of the grinding wheel to and from the work is controlled automatically by a cam on a shaft at the rear, which connects by direct means with the slide. The adjustment of the wheel slide to compensate for wear, when this becomes necessary, is accomplished from the front of the machine. This grinder can also be arranged as a semi-automatic machine by a slight modification of the carriage and the substitution of centers for the automatic chucking mechanism.

Polishing Machine: Robinson Automatic Machine Co., Detroit, Mich. Automatic polishing machine designed for polishing stove plates or any surfaces that are free from abrupt angles. This machine is made in four sizes, and it can be operated by one man. The work while being polished is moved slowly in a longitudinal direction along a carriage operated by an endless chain, and the surface is polished by wheels which have, in addition to a rapid rotary motion, a backward and forward movement across the work. These wheels are made of glued cotton sections similar to those on hand polishers. The first wheel under which the work passes is usually covered with emery cloth to remove the scale, and the last one is a leather finishing wheel of the regular type. The machine is equipped with a blower having an opening back of each wheel to carry away the dust. It is claimed that a saving varying from 50 to 80 per cent on different classes of work, may be effected with this machine, as compared with hand labor.

Turret Lathe: Warner & Swasey Co., Cleveland, O. Combination turret lathe designed to handle a wide range of bar-stock work and forgings. Bar stock up to 3⅛ inches in diameter can be fed through the automatic chuck, and lengths up to 36 inches can be turned at one chucking. Castings and forgings up to 15 inches in diameter can be handled with the chucking outfit. The swing over the bed is 23 inches and over the carriage 17½ inches. The turret is of the hollow, hexagon type and measures 16½ inches across the faces. The turret saddle has ten feed changes, and there are twelve independent adjustable stops that are indexed with the turret and operate automatically. The carriage is of the side type, and has a square turret for holding four tools. It also has ten automatic, longitudinal and cross feeds. There are six independent adjustable stops for the longitudinal travel and the cross feed has one stop in each direction. The turret and carriage have separate feed-rods, so that the feeds are independent of each other, and both are provided with adjustable automatic trips. This machine is built with either a cone or single pulley type of drive.

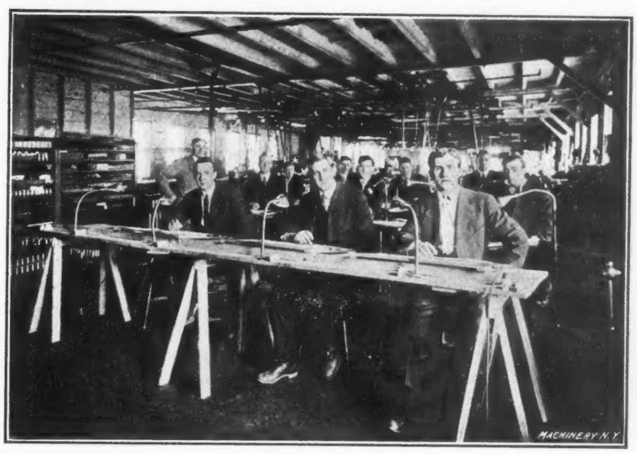
* * *

T. R. ALMOND MFG. CO.'S EVENING SCHOOL

An evening school has been opened by the T. R. Almond Mfg. Co., at its factory in Ashburnham, Mass., to teach the machinists how to read and make mechanical drawings. This is in harmony with the progressive policy of the company, it being the belief that the broader the knowledge of the employes, the better the work produced.

The accompanying halftone illustration shows the drawing school in session. It will be noticed that the improvised tables, constructed of boards and wooden horses, are lighted with Almond "Flexo" lamps, conveniently arranged to meet every requirement of lighting.

This instructive work, instituted by the chief draftsman, Mr. K. P. Albridge, will be continued under his direction. A course consisting of twenty-four lessons has been planned, which will supply the knowledge most needed by the employes of the company. For the purpose of simplifying the technical problems, and to convey the elementary principles to the best advantage, Mr. Albridge intersperses his work with lectures illustrated with black-board drawings.



Evening School of the T. R. Almond Mfg Co. held in the Shop. Note the Improvised Tables

School lessons are held twice a week and all who have enrolled will be given a broad and comprehensive knowledge of mechanical drawings, ranging from elementary problems to working drawings in gearing. The classes will be continued until the completion of the twenty-four lessons and will be resumed in the fall. Needless to say, the project has awakened keen interest among the men, and the opening session showed a generous representation.

* * *

Every man has a right to his choice of grinding wheels, but the best way to make an intelligent choice is by occasional experimenting with an open mind to determine the relative merits of various makes.

SPRING MEETING OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The spring meeting of the American Society of Mechanical Engineers was held in Pittsburg, May 30–June 2, the meeting place being Carnegie Institute and the headquarters Hotel Schenley, nearby. The registration of members was 300, and guests 346, making a total registration of 646. The registration of members was the largest of any spring meeting since the Chicago meeting in 1904. The inspection trips to various plants in Pittsburg and vicinity were of unusual interest, and the opportunities to see the manufacture of cement, butt- and lap-welded tubes, heavy engines, steel, etc., were keenly enjoyed by all. The local committee, of which Mr. E. M. Herr was chairman and Mr. Elmer K. Hiles, secretary, was untiring in its efforts to make the meeting successful in every way. A handsome and interesting 56-page booklet was issued containing illustrations and brief descriptions of the leading industries of Pittsburg (most of which were open to inspection by members), historical matters and general features of interest to the visiting engineers.

A pleasing incident of the opening session Tuesday evening was the presentation in behalf of the membership of a beautifully engrossed and illuminated testimonial to Col. E. D. Meier, president, in remembrance of his seventieth birthday. Announcement was made that Col. Meier would later be presented with his portrait done in oils.

Following is a list of the papers read and discussed:

"Some Problems of the Cement Industry," by Walter S. Landis.

"Edison Roll Crushers," by W. H. Mason.

"Power and Heat Distribution in Cement Mills," by L. L. Griffiths.

"The Assembly of Small Interchangeable Parts," by John Calder.

"Process of Assembling a Small and Intricate Machine," by Halcolm Ellis.

"Quantity Manufacture of Small Parts," by F. P. Cox.

"Milling Cutters and Their Efficiency," by A. L. DeLeeuw.

"Discussion of Large Gas Power Plants," by A. E. Maccoun and others.

"The Work of the U. S. Bureau of Mines," by S. B. Flagg and C. D. Smith.

"Stresses in Tubes," by Reid T. Stewart.

"The Purchase of Coal," by D. T. Randall.

"Energy and Pressure Drop in Compound Steam Turbines," by F. E. Cardullo.

"The Pressure-Temperature Relations of Saturated Steam," by L. S. Marks.

"A Pressure Recording Indicator for Punching Machinery," by G. C. Anthony.

"Commercial Application of the Turbine Turbo-Compressor," by R. H. Rice.

"Reciprocating Blast Furnace Blowing Engines," by W. Trinks.

"Power Forging, with Special Reference to Steam-Hydraulic Forging Presses," by Barthold Gerdau and George Mesta.

The papers on the cement industry were appropriately followed by a visit in the afternoon to the Universal Portland Cement Co.'s plant at Universal, Pa., which has a capacity of 10,000 barrels of slag cement per day. A special train of Pullman cars was provided by the company to transport the members and guests to the plant. On the return trip the Westinghouse Electric & Mfg. Co.'s, and Westinghouse Machine Co.'s, works at East Pittsburg were inspected.

Following the reading of the paper on "Milling Cutters and Their Efficiency," by A. L. DeLeeuw, (see May number for abstract), Mr. Elmer H. Neff of the Brown & Sharpe Mfg. Co. read a discussion by Mr. Parker of the same company, which disclosed the fact that the Brown & Sharpe Mfg. Co. has used milling cutters with wide spaced teeth for a number of years with success, when the conditions were favorable. While certain advantages were conceded, the wide spaced milling cutter in Mr. Parker's opinion is poorly adapted for general work. The power of many milling machines in use is inadequate, as are the clamping facilities also, the effect being pounding of the work which loosens it in the vise and produces unsatisfactory results. In his closure, Mr. DeLeeuw deplored the fact that the Brown & Sharpe Mfg. Co. had not made the results of its investigations public and saved others the trouble and expense of conducting independent experiments.

In the discussion of the paper "A Pressure Recording Indicator for Punching Machinery," Mr. Julian Kennedy briefly remarked that in his opinion a more reliable means for indicating the pressure of a punch than a hydraulic cylinder and piston, is a steel bar supported at the ends and loaded in the center. A uniformly tempered steel bar would give an accurate index of the load and not be subject to leakage, frictional resistance and other drawbacks attending the use of hydraulic cylinders and pistons.

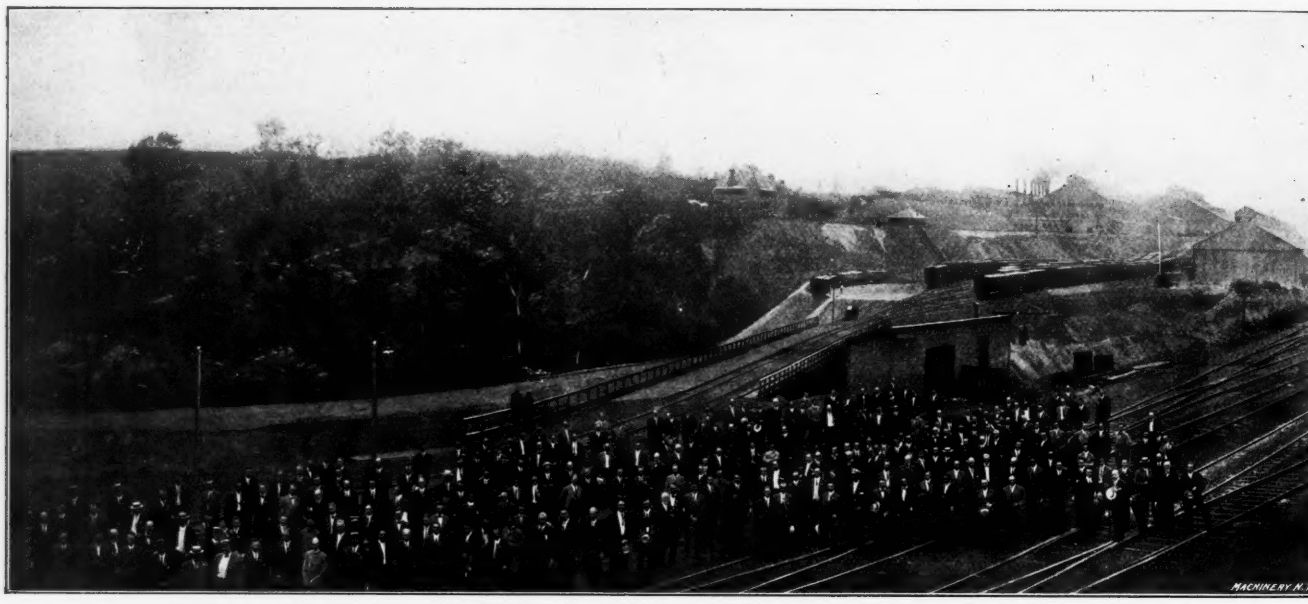


Fig. 1. The American Society of Mechanical Engineers' Party at the Universal Portland Cement Co.'s Works, Universal, Pa., May 31

Copies of a schedule of standard weight flange fittings and extra heavy flange fittings were circulated, but no discussion of importance developed. The schedule has been adopted by the National Association of Steam and Hot Water Fitters, and the American Society of Mechanical Engineers will probably recommend it as a standard for general use of engineers. The policy of the A. S. M. E. is to adopt no standard as such, but to print data in the proceedings of the Society, thus in effect recommending them to the consideration of members.

An event of general interest was the visit to the National Tube Co.'s works at McKeesport to inspect the manufacture of butt- and lapp-welded tubes. The plant is one of the best in the world, being completely equipped for the production of tubes from the ore. The tube mill is said to be the largest building in the world, being 600 feet wide, 1600 feet long, and covering an area of 23 acres. The members inspecting the plant went by street cars and most of them returned by boat, taking the special excursion steamer that had been

chartered for the day and which touched up at McKeesport dock on the return trip to the city.

Thursday evening was the occasion of a reception and dance at the Hotel Schenley for members, ladies and other guests.

On Friday an inspection trip was taken to the Carnegie Steel Co.'s works at Duquesne, and the Mesta Machine Co.'s works at West Homestead, to see the manufacture of steel and the building of large blowing and rolling mill engines.

Friday evening was the occasion of a smoker and entertainment given in honor of the American Society of Mechanical Engineers by the Engineers' Society of Western Pennsylvania, in the Union Club, Frick Building, on which occasion Mr. George H. Neilson presented "A Near History of Crucible Steel," which, quoting from the program, was a wonderful effort, as witness: "This erudite elucidation enounces every evolution, exposes erstwhile elusive errors, eclaircizes each esoteric essential, eliminates extraneous eristical evanescent, eccentricities, even excogitates exceptionally exact ectypes embracing every element."

* * *

The great White Star liner *Olympic*, arrived in New York harbor June 21 on her first voyage. The new vessel is 882½ feet long, 92½ feet wide, 97 feet from bottom of keel to boat deck, 66,000 tons total displacement and 45,000 tons register. The *Olympic* is equipped with triple screws driven by reciprocating engines and a turbine. The outboard propellers are driven by engines and the center propeller by the low-pressure turbine supplied with exhaust steam from the reciprocating engines. The great size of the vessel is indicated by the weight of some of the gear. The rudder alone, which is electrically operated, weighs 100 tons, the anchors 15½ tons each, the center propeller 22 tons and the outboard or "wing" propellers 38 tons each. Each link of the anchor chain weighs 175 pounds. The main dining room is 90 feet wide by 114 feet long, and seats 532 persons. The vessel has accommodations for 650 first-class passengers, 500 second-class, and 1500 third-class. The officers and crew, including the stewards' department, number 860.

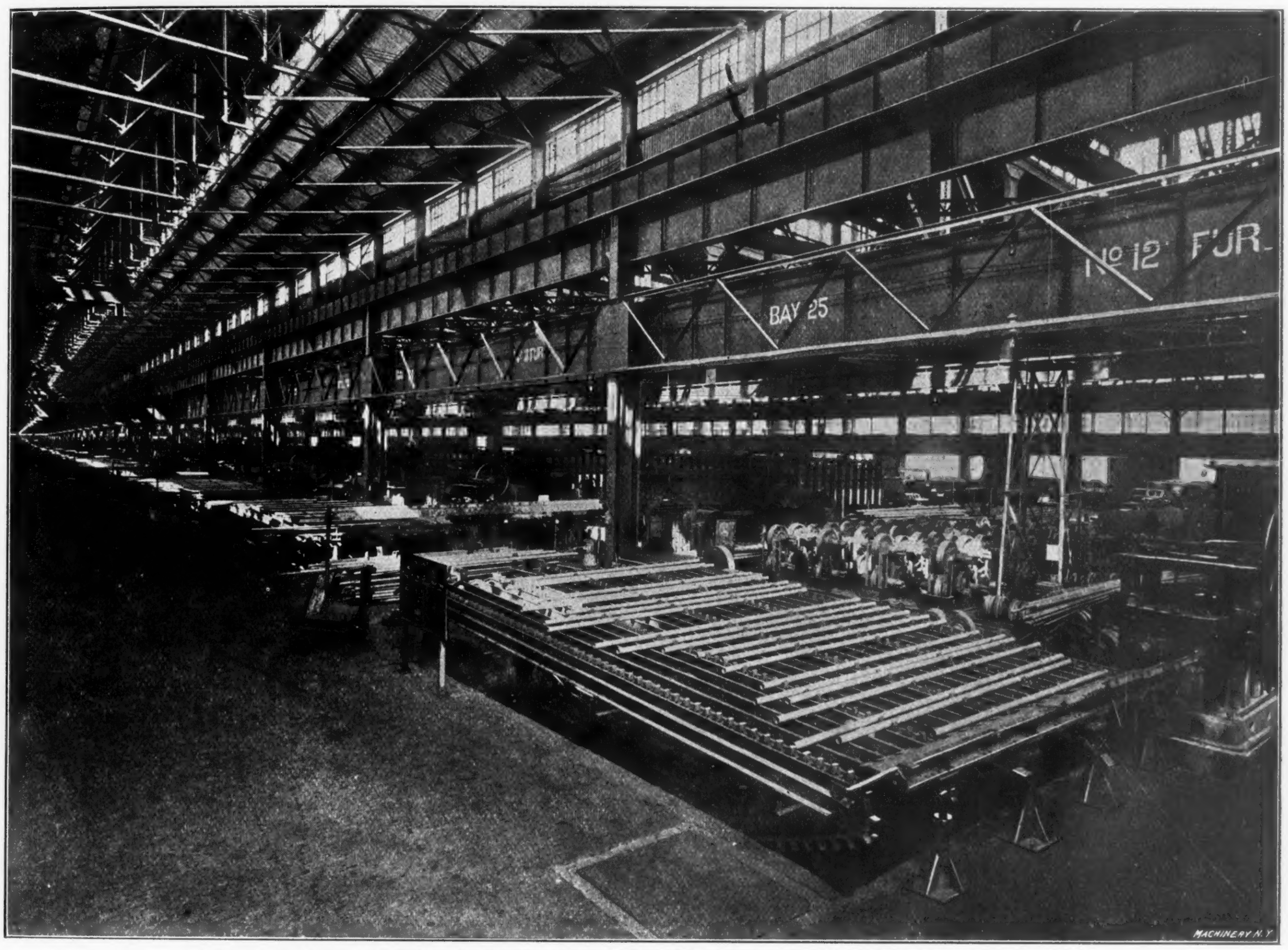


Fig. 2. Interior of the National Tube Co.'s Tube Mill at McKeesport, Pa., visited June 1 by the A. S. M. E.

A. R. M. M. AND M. C. B. ASSOCIATIONS CONVENTIONS

The forty-fourth annual convention of the American Railway Master Mechanics' Association and the forty-fifth annual convention of the Master Car Builders' Association, were held at Atlantic City, N. J., June 14 to June 21, inclusive. The American Railway Master Mechanics' Convention was held June 14, 15 and 16, and the Master Car Builders' Convention June 19, 20 and 21, the order of priority alternating with that of last year, as is the long-established custom.

The technical program of the American Railway Master Mechanics' Association consisted for the greater part as usual of topical discussions and papers on various phases of locomotive design and operation, as follows:

June 14.—Discussion of reports on: "Mechanical Stokers"; "Revision of Standards"; "Smoke Preventing Devices for Firing-up Locomotives at Terminals"; "Best Construction of Locomotive Frames."

June 15.—Discussion of reports on: "Main and Side Rods"; "Piston Rods and Crossheads"; "Repair Equipment for Roundhouses"; "Water Treatment"; "Lubrication of Locomotive Cylinders"; "Consolidation of the American Railway Master Mechanics' and Master Car Builders' Associations"; "Locomotive Performance Under Different Degrees of Superheated Steam," by Prof. C. H. Benjamin.

June 16.—Discussion of reports on: "Safety Appliances"; "Design, Construction and Inspection of Locomotive Boilers"; "Contour of Tires"; "Steel Tires"; "Flange Lubrication"; "Minimum Requirements for Headlights."

The following officers were elected for the A. R. M. M. Association:

President, H. T. Bentley, Chicago & Northwestern Ry.
First vice-president, D. F. Crawford, Pennsylvania Lines.
Second vice-president, T. Rumney, Erie R. R.
Third vice-president, D. R. MacBain, L. S. & M. S. Ry.
Treasurer, Angus Sinclair, 114 Liberty St., New York.
Secretary, Joseph W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

The program of the Master Car Builders' Association was also largely made up of reports and papers, as follows:

June 19.—"Revision of Standards and Recommended Practice"; "Train Brake and Signal Equipment"; "Brake Shoe Equipment."

June 20.—Discussion of reports on: "Rules for Loading Materials"; "Rules of Interchange"; "Prices for Labor and Materials for Steel Cars"; "Coupler and Draft Equipment"; "Car Wheels"; "Safety Appliances"; "Revision of Code of Air Brake Tests"; "Freight Car Trucks"; "Refrigerator Cars."

June 21.—Discussion of reports on: "Consolidation of Master Car Builders' and Master Mechanics' Associations"; "Springs for Freight Car Trucks"; "Lumber Specifications"; "Train Lighting and Equipment"; "Train Pipe Connections for Steam Heat."

The following officers were elected for the M. C. B. Association:

President, A. Stewart, Southern Ry.
First vice-president, D. F. Crawford, Pennsylvania Lines.
Second vice-president, C. E. Fuller, Union Pacific R. R.
Third vice-president, M. K. Barnum, Illinois Central R. R.
Treasurer, J. S. Lentz, Lehigh Valley R. R.
Executive Committee—F. W. Brazier, N. Y. C. & H. R., C. A. Schroyer, C. & N. W., and A. Kearney, N. & W.

The Railway Supply Manufacturers' Association held an exposition of railway car and locomotive parts, and supplies, apparatus, etc., on Young's New Pier. This exhibit of railway supplies is one of the most important held annually in the United States, and grows yearly in importance. Last year the exhibit space was 71,500 square feet and many would-be exhibitors were turned away. This year the total exhibit space was increased about 5000 square feet, and still accommodations were lacking for about seventy concerns. About 260 exhibits were assigned spaces and 70 applicants for space were turned away.

An improved Pond car-wheel lathe on the Boardwalk near the exhibition pier was in operation—demonstrating the great capacity of high-speed steel, the power of the modern machine tool and the ability of the well-trained men in charge. An example of the demonstration was a pair of 36-inch steel-tired coach wheels finished in seventeen minutes from the time of rolling them into the lathe to the time they were rolled out of the way and another pair put in place. Pneumatic clamps for toolposts and tailstocks and pneumatic adjusting cylinders for the tailstocks reduced the physical labor of operation to a minimum. The lathe was driven by a 55 H. P. electric motor.

The exhibit of the United Engineering & Foundry Co., on Mississippi Ave., comprising a complete forging plant on a flat car, attracted much attention. The plant consisted of a steam-hydraulic intensifier forging press of 150 tons capacity, vertical steam boiler and Tate, Jones & Co., Inc., oil fuel furnace. Billets weighing 200 pounds were quickly and almost noiselessly drawn into shapes approximating the dimensions of locomotive piston-rods.

Exhibitors of Metal-working Machines, Accessories and Allied Products

Ajax Mfg. Co., Cleveland, Ohio. Machine-made forgings.

American Tool Works Co., Cincinnati, Ohio. Motor-driven 24-inch engine lathe (see March and June, 1911, numbers for illustrated descriptions); 24-inch back-geared crank shaper; 3-foot back-geared and 6-foot plain radial drilling machines.

American Vanadium Co., Pittsburg, Pa. Vanadium iron and steel products, comprising locomotive parts, automobile parts, etc., some of which had been subjected to severe physical tests to demonstrate great elasticity and strength.

Armstrong-Blum Mfg. Co., Chicago, Ill. "Marvel" automatic high-speed hacksaw.

Armstrong Bros. Tool Co., Chicago, Ill. Lathe and planer tool-holders, ratchet drills, lathe dogs, and other high-grade accessories made by this company.

Besly & Co., Charles H., Chicago, Ill. Patternmakers' disk grinder, taps, oil, babbitt spiral circles, etc.

Bullard Machine Tool Co., Bridgeport, Conn. 42-inch vertical turret lathe (see June number for illustrated description); 64-inch boring drill, maxi-mill type, both motor driven and running.

Cleveland Twist Drill Co., Cleveland, Ohio. Demonstrations of high-speed drills and reamers.

Cochrane-Bly Co., Rochester, N. Y. 8-inch capacity cold saw cutting-off machine; 4½-inch capacity cold saw cutting-off machine; automatic saw sharpener; die filing machine.

Crucible Steel Co. of America, Chicago, Ill. Exhibit of "Rex AA" high-speed steels and tools made of same.

Davis-Bournonville Co., New York, N. Y. Oxy-acetylene welding and cutting equipment for railroads and large manufacturing plants, navy yards, etc.

Detroit Hoist & Machine Co., Detroit, Mich. Pneumatic hoists, motors, etc.

Foster Co., Walter H., New York, N. Y. Hydro-pneumatic radial drill; all-geared multi-spindle drill and pneumatic staybolt nipper.

General Electric Co., Schenectady, N. Y. Centrifugal air compressor, portable air compressor for railway shops and other electrical apparatus for railway purposes.

Goldschmidt Thermit Co., New York, N. Y. Appliances for making thermit welds, samples of welding, etc.

Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa. Hand-operated portable chain hoists, screw hoists and differential hoists.

International Correspondence Schools, Scranton, Pa. Books, and work done by students.

Jessop & Sons, Inc., Wm., New York, N. Y. Samples of Jessop tool steels.

Johns-Manville Co., H. W., New York, N. Y. Asbestos products.

Landis Machine Co., Waynesboro, Pa. Double-head 1½ inch Landis bolt cutter, single-head Landis bolt cutter; open die head for turret lathes, etc.

Landis Tool Co., Waynesboro, Pa. 16- by 72-inch plain self-contained grinding machine and 12- by 32-inch universal grinding machine.

Lucas Machine Tool Co., Cleveland, Ohio. Lucas horizontal boring machine and power forcing press.

Manning, Maxwell & Moore, Inc., New York, N. Y. Hancock inspirators, valves, Celfor drills, steam gages, etc.

Matthews-Davis Tool Co., St. Louis, Mo. Davis expansion boring tools.

National Tube Co., Pittsburg, Pa. Kewanee pipe fittings, comprising unions, union ells, tees; flange unions; test pieces from boiler tubes, etc.

Niles-Bement-Pond Co., New York, N. Y. New model motor-driven car-wheel lathe in operation.

Rockwell Furnace Co., New York, N. Y. Furnaces for heat treatment of metals.

Royersford Foundry & Machine Co., Inc., Royersford, Pa. Sells roller bearing shaft hanger box; power punch and shear.

Sellers & Co., Inc., William, Philadelphia, Pa. Locomotive injectors and accessories; locomotive wheel lathe parts, etc.

Sprague Electric Works of General Electric Co., New York, N. Y. Armored air brake hose; pneumatic and hydraulic hose; armored electric conductors; etc.

Underwood & Co., H. B., Philadelphia, Pa. Pipe bender and straightener; portable cylinder boring bar, etc.

Union Mfg. Co., New Britain, Conn. Complete line of chucks made by the company.

Van Dorn & Dutton Co., Cleveland, Ohio. Electrically-operated portable drilling and reaming machines.

Vandyck Churchill Co., New York, N. Y. Higley cutting-off machine.

Warner & Swasey Co., Cleveland, Ohio. New hollow hexagon turret lathe.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Alternating and direct current motors, control apparatus, etc.

Yale & Towne Mfg. Co., New York, N. Y. Chain blocks, trolleys, electric hoists, hardware, etc.

* * *

SUMMER MEETING OF THE SOCIETY OF AUTOMOBILE ENGINEERS

The summer meeting of the Society of Automobile Engineers was held in the Algonquin Hotel, Dayton, Ohio, June 15-17, and the following program of technical papers and discussions was presented:

June 15.—Opening address by the president, Henry Souther. Reports of Standards Committee Division: (*a*) "Iron and Steel Division," Henry Souther; (*b*) "Aluminum and Copper Alloys Division," W. H. Barr; (*c*) "Seamless Steel Tubes Division," H. W. Alden; (*d*) "Nomenclature Division," P. M. Heldt; "The Question of Long- Versus Short-Stroke Gasoline Motors," by J. B. Entz; "Long Addendum Gears," by E. W. Weaver; "The Influence of the Engineer on the Sales Department," by William P. Kennedy. Report of Wheel Dimensions and Fastenings for Tires Division.

Discussions.—"Special Methods of Loading Commercial Vehicles"; "Dumping Trucks"; "Auxiliary Apparatus for Commercial Vehicles"; "Trailers for Commercial Vehicles"; "Location of Working and Emergency Brakes."

June 16.—"Elements of Ball and Roller Bearings Design," by Arnold C. Koenig; "Worm Gears and Wheels," by E. R. Whitney. Reports of Standards Committee Division: (*e*) "Ball Bearings Division," David Ferguson; (*f*) "Broaches Division," Charles E. Davis; (*g*) "Carbureter Division," G. G. Behn; (*h*) "Frames Division," James H. Foster.

Discussions.—"Transmission Location—Whether on Rear Axle or Attached to Car Frame"; "Underslung Frames."

June 17.—"Rotary Gasoline Motors," by C. E. Mead; "Some Points on the Design of Aluminum Castings," by H. W. Gillett; "Oversize Standards for Pistons and Rings," by James N. Heald. Reports of Standards Committee Division: (*i*) "Lock Washer Division," J. E. Wilson; (*j*) "Sheet Metals Division," James H. Foster; (*k*) "Springs Division," A. C. Bergmann, (*l*) "Miscellaneous Division."

Discussions.—"Multiple-Disk Clutches"; "Six-Cylinder Versus Four-Cylinder Motors of Equal Rating."

SMALL FLEXIBLE SHAFT AND MACHINES BY WHICH IT IS MADE

The accompanying line engraving Fig. 1 shows at *A* a drawing of a small flexible shaft (full size) made by the Veeder Mfg. Co., Hartford, Conn. As will be noted, this flexible shaft is composed of alternate links and sleeves held together by pins passing through holes in the sleeves and elongated openings in the links. At *B* and *C* in the same illus-

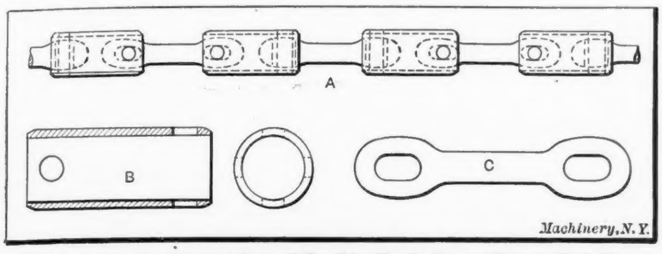


Fig. 1. A Simple Construction of Flexible Shaft—Upper View is Full Size, Lower Views are Twice Actual Size

tration the links and sleeves are shown twice their actual size, in order to clearly indicate their appearance. The sleeves are cut off in an automatic screw machine from tubing, the ends being slightly chamfered at the same time. The links are also formed and cut off in an automatic screw machine. In the following are illustrated and described the machines used for drilling the holes in the sleeves, and for milling the elongated holes in the links.

For drilling the sleeves, the machine illustrated in Fig. 2, which drills the four holes in the sleeves at once, is used. In Fig. 3 is shown a line engraving giving the details of the construction of this four-spindle machine. By referring to Figs. 2 and 3, it will be seen that the drills are guided in bushings in a stud in the center of the machine, in which the sleeve is inserted. The sleeve is held while drilling by a draw-in chuck operated by handle *F*. Each of the spindles is of the drill spindles, as shown clearly in Fig. 2. This pinion is also shown in the sectional view in Fig. 3, and is indicated by the letter *B*. On the stud *C*, on which this pinion is mounted, gear teeth are also cut, engaging with a circular rack *D* which is mounted on the drill spindle. In this way the motion from handle *A* is transmitted through the spur gear into which it is inserted, and through gears *B* and *C*, to the drill spindle, feeding it in or removing it from the work, as the case may be. As it is required that the spindle move back and forth in its pulleys, a special kind of sliding keyway provided with rollers, as shown at *E* in Fig. 3, has been provided.

For milling the elongated hole in the ends of the links *C*, Fig. 1, the machine shown in Fig. 4 is used. The links are

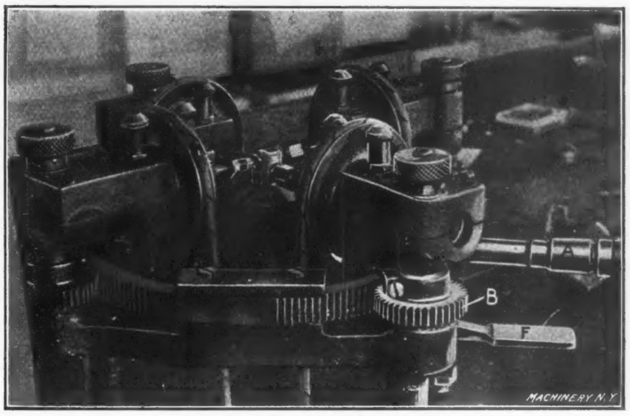


Fig. 2. Sleeve Drilling Machine

held in the small holder *A* shown removed from the machine and resting against its base. Two links can be clamped in this holder at once, one on each side of the center stud, the links being held in a horizontal position while milling. The oblong holes in the links are milled by small end-mills held in

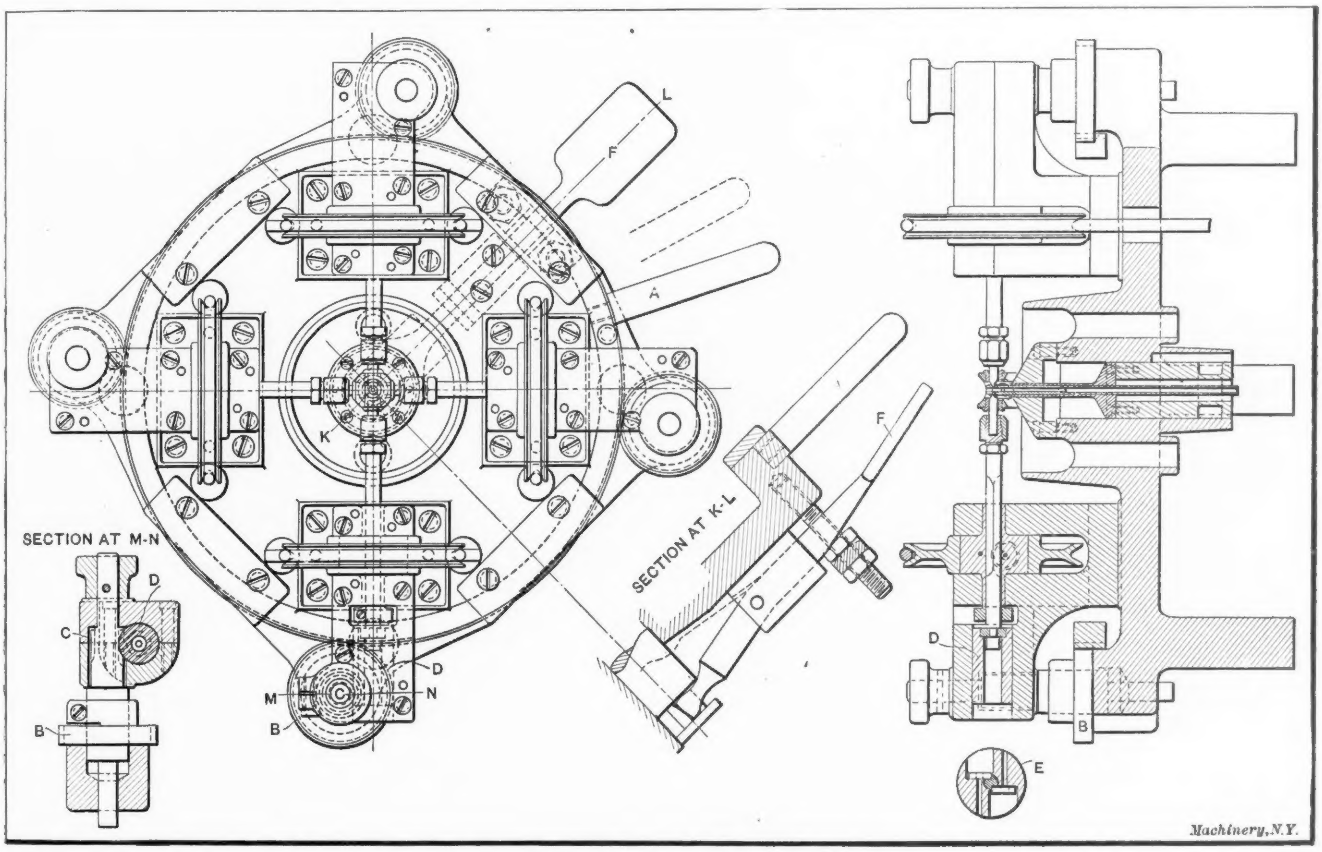


Fig. 3. Construction of Sleeve Drilling Machine

driven from a pulley of its own by a round belt, the spindle pulleys being placed underneath the bench on which the machine is mounted, and all are driven from a common driving pulley. The drills are fed into the work by a slight movement of handle *A*. This handle is inserted in the rim of a large spur gear which engages with a pinion opposite each the two spindles of the machine shown at *B*. When in operation, the machine mills the two elongated slots at one end of the two links at once, and then the slots at the other end. It will be noticed that slide *A* is provided with two grooves *C* on the extending stem. At *D* is a locking arm which can engage with either of these two grooves. When the locking

arm engages with the outer groove, the holes in one end of the links are being milled, and as soon as the operation is completed, the locking arm is lifted, the slide is pulled out and the arm placed in engagement with the inner of the two grooves *C*. Now the two remaining slots in the links are

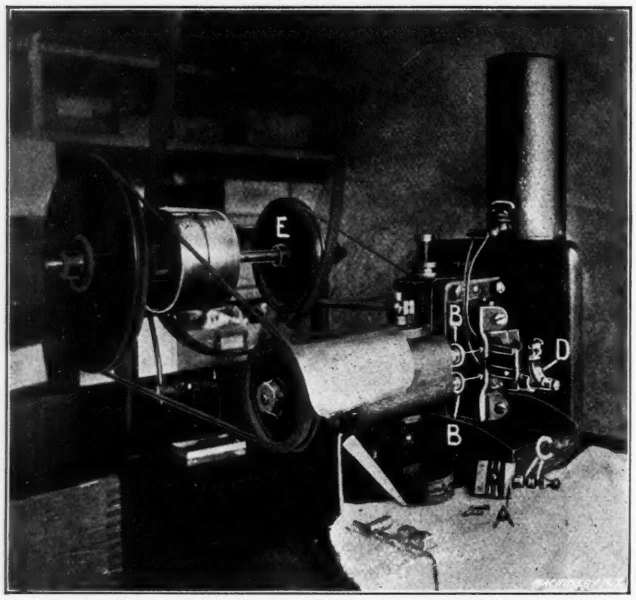


Fig. 4. Machine for Milling Oblong Holes in Flexible Shaft Links

milled. The operation is very rapid. While milling, slide *A* is reciprocated by a motion transmitted to the machine from pulley *E*, so that the end-mill will cut an oblong hole in the link.

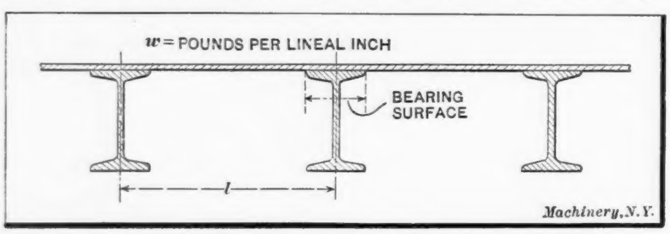
* * *

MAXIMUM CENTERS OF BEAMS FOR STEEL TANK BOTTOMS

By EDMUND B. LA SALLE*

In designing steel tanks, it is necessary to know the spacing of the supporting beams for a given head of water and a given thickness of plate; sometimes two of these factors are known, and it is required to find the third. Having to design numbers of steel-tank floor systems for the company with which the writer is connected, the accompanying table was developed.

The working conditions of the floor are shown in the illustration. Here the tank bottom is a continuous beam sup-



Section of Bottom of Steel Tank showing Continuous Beam Analogy

ported by I-beams or wooden beams, as required by specification. Now the maximum bending moment for a continuous beam is given by different authorities as either $\frac{w\,l^2}{12}$ or $\frac{w\,l^2}{13}$ where w is the weight per lineal inch and l, the distance between centers in inches. The table is based on the latter value, which is approximately the same as that given by Trautwine for a continuous beam with six or more supports. With beams spaced by these original tables it appeared that the flooring was unduly strong, so for that reason the maximum bending moment formula was changed to $\frac{w\,l^2}{15}$ by changing the denominator from 13 to 15, which, when introduced into the beam equation, reduces the weights of the parts.

That this assumption of a smaller bending moment is justifiable may be readily recognized by a little consideration. The floor plate, when resting on the supporting beams, has a bearing surface never less than 3 inches in width; thus the actual unsupported distance between beams is reduced by that amount. This, however, is not considered in the value of l introduced in the bending moment formula, so that compensation is obtained by changing the constant. Also, when the deflection is large the plate will assume a corrugated surface with a curve like the catenary. The writer considers that this tends to substitute a pure tensile stress for that of bending; this, however, is his own assumption.

As an example, suppose it is desired to find the center distances of supporting beams when 5/16-inch plate is used as flooring under a 26-foot head of water. By looking up the

TABLE OF MAXIMUM CENTERS OF BEAMS

Maximum Centers of Beams in Inches

Thickness, Inches	Height of Water in Feet											
	4	6	8	10	11	12	13	14	15	16	17	18
3/16	27½	22½	19½	17½	16½	15⅞	15¼	14¾	·4¼	13¾	13¼	12⅞
1/4	36¾	30	26	23¼	22	21⅛	20¼	19½	18⅞	18¼	17¾	17¼
5/16	46	37½	32½	29	27¾	26½	25½	24½	23¾	23	22¼	21⅝
3/8	55	45	39	34¾	33¼	31¾	30½	29½	28½	27½	26¾	26
7/16	64	52½	45⅜	40½	38¾	37⅛	35⅝	34⅜	33¼	32⅛	31¼	30⅜
1/2	73½	60	52	46½	44¼	42⅜	40¾	39¼	38	36¾	35⅝	34⅝

Thickness, Inches	Height of Water in Feet											
	19	20	21	22	23	24	25	26	27	28	29	30
3/16	12½	12¼	12	11¾	11½	11¼	11	...	...	...	...	...
1/4	16¾	16⅜	16	15⅝	15¼	15	14⅝	14⅜	14⅛	13⅞	13⅝	13⅜
5/16	21	20½	20	19½	19⅛	18¾	18⅜	18	17⅝	17¼	17	16¾
3/8	25¼	24⅝	24	23½	23	22½	22	21⅝	21¼	20⅞	20½	20⅛
7/16	29½	28¾	28	27⅜	26¾	26⅛	25⅝	25⅛	24¾	24¼	23⅞	23½
1/2	33¾	32¾	32	31¼	30⅝	30	29⅜	28¾	28¼	27¾	27¼	26¾

Thickness, Inches	Height of Water in Feet											
	32	34	36	38	40	42	44	46	48	50	55	60
1/4	13	12⅝	12¼	11⅞	11⅝	11¼	11	...	...	...	...	...
5/16	16¼	15¾	15¼	14⅞	14½	14⅛	13¾	13½	13¼	13	12⅜	11¾
3/8	19½	18⅞	18⅜	17⅞	17⅜	17	16⅝	16¼	15⅞	15½	14⅞	14¼
7/16	22¾	22	21⅜	20⅞	20⅜	19⅞	19⅜	19	18⅝	18⅛	17¼	16½
1/2	26	25¼	24½	23⅞	23¼	22⅝	22⅛	21⅝	21⅛	20¾	19¾	19

table, the spacing will be found to be 18 inches. It might be mentioned that, in the table, the maximum assumed stress is taken as 15,000 pounds per square inch, which works out to a factor of safety of about 4.

* * *

The man who undertakes the cultivation of strength of character simply by learning to say No, is likely to develop more cussed crankiness than real character, because other things than negatives are necessary in a strong character.

* * *

PERSONALS

William Wolfred, for the past five years general foreman of the Atlas Engine Works, Indianapolis, Ind., assumed the superintendency of the motor shops of the same company June 12.

Willard C. Brinton, formerly with the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., is now assistant vice-president of the United States Motor Co., 61st St. and Broadway, New York City.

R. H. Wadsworth, formerly assistant superintendent of the Waverley Co., Indianapolis, Ind., has been made general superintendent and works manager of the Seneca Falls Mfg. Co., Seneca Falls, N. Y.

H. A. Hunt has been appointed Eastern sales agent for the Edgar Allen American Manganese Steel Co., with headquarters at New Castle, Del. The appointment was made in order to fill the vacancy caused by the resignation of Mr. V. W. Mason, Jr.

Joseph V. Woodworth, formerly superintendent of the Harwood Mfg. Co., Brooklyn, N. Y., and author of several books on machine shop practice, is now with the Taft-Peirce Mfg. Co., Woonsocket, R. I., as consulting engineer and expert in sheet-metal formation and punch and die practice.

* Address: 159 Harrison St., Batavia, Ill.

L. A. Breitinger, president and general manager of the American Cuckoo Clock Co., Philadelphia, Pa., recently invented and installed a device in his plant which enables persons in any part of the works to immediately shut down all the machinery either in that particular department or the entire plant in a few seconds.

George Braithwaite, factory manager of the Stevens-Duryea Co., Chicopee Falls, Mass., has resigned to become production manager of Thomas B. Jeffrey & Co., Kenosha, Wis. Mr. Braithwaite was first employed by the Stevens-Duryea Co. nine and a half years ago as a toolmaker, and his rapid rise is due to his native ability as a manager of men. Substantial testimonials of regard were presented to Mr. Braithwaite by the six hundred and fifty employes upon his departure.

John M. Shrigley, president of the Williamson Free School of Mechanical Trades, was honored with the degree of Master of Arts by Swarthmore College at her recent commencement, June 7, 1911. It is interesting to note that Swarthmore is the first college to especially honor a person who has devoted his whole career, in educational lines especially, to industrial work, which has been the relation of President Shrigley to school life. The degree was given in recognition of Williamson and her achievements under the efficient management of the president.

W. H. Stillwell, electrical engineer, has just joined the engineering and selling force of the J. S. Bretz Co., the importers of the F. & S. annular ball bearings, German steel balls, U. & H. master magneto, and Bowden wire mechanism. Mr. Stillwell, who graduated from Purdue University in 1906, has since that time been associated with the Westinghouse Electric & Mfg. Co., and during the past year has specialized on the sale of motors and controllers for electric vehicles. He will make his headquarters at the New York office of the J. S. Bretz Co., looking after the trade in Cleveland and all the territory east of it, included in the Middle and New England states.

* * *

OBITUARY

W. H. Herbert, director of Alfred Herbert, Ltd., Coventry, England, from the time of formation of the company, in 1894, died at his residence, The Grange, Coventry, June 10.

* * *

COMING EVENTS

July 6-8.—Semi-annual meeting of the American Society of Heating and Ventilating Engineers, Chicago, Ill. W. W. Macon, secretary, 29 West 39th St., New York.

August 15.—Annual meeting of the International Railroad Blacksmiths' Association, Toledo, Ohio. A. L. Woodworth, secretary, Lima, Ohio.

August 29-Sept. 1.—Nineteenth annual convention of the Traveling Engineers' Association, at the Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, c/o New York Car Shops, East Buffalo, N. Y.

November 2-4.—Annual meeting of the International Society for the Promotion of Industrial Education, Cincinnati, Ohio. R. T. Davis, secretary, 18 W. 44th St., New York City.

SOCIETIES AND COLLEGES

Newberry College, Newberry, S. C. Register 1910-1911; announcements for 1911-1912.

Delaware College, Newark, Del. Register for 1910-1911; announcements for 1911-1912.

Louisiana State University, Baton Rouge, La. Catalogue, 1910-1911; announcements, 1911-1912.

David Ranken, Jr., School of Mechanical Trades, St. Louis, Mo. Second annual catalogue, 1911-1912.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of the College of Engineering, 1911-1912.

New Mexico School of Mines, Socorro, N. M. Annual register for 1910-1911; announcements for 1911-1912.

NEW BOOKS AND PAMPHLETS

Magnetic Properties of Heusler Alloys. By Edward B. Stephenson. 38 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

This bulletin is a contribution of data on the subject of magnetic alloys, and describes fully the methods of magnetic testing, thermal analysis and photo-micrography used in the work. The results show that an alloy of ferro-magnetic properties comparable with those of cast iron can be made of the non-magnetic components copper, manganese and aluminum, and that the magnetic properties depend largely on the heat treatment.

Air-Brake Catechism. By Robert H. Blackall. 352 pages, 4½ by 7 inches. 117 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $2.

Through so many editions (this is the twenty-fifth) has this book passed, that but little further need be said regarding its value. It fully covers all the air-brake equipment manufactured by the Westinghouse Air Brake Co., describing it in a manner calculated to be intelligible to the class of men for whom it is written. In addition, it contains 2000 questions and answers, intended as examination questions for engineers and firemen, and all other railroad men, preparing to pass an examination on the subject of air brakes.

Train Rule Examinations Made Easy. By G. E. Collingwood. 234 pages, 4 by 6½ inches. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $1.25.

Throughout the book the author has endeavored to explain the train rules and train orders in such a way as to make them as clear as possible. The factors which have been instrumental in developing the present system of train operation are mentioned whenever it seems necessary to better enable the student to understand the necessity of any particular rule. The rulings throughout are based on those made from time to time by the American Railway Association. The 234 pages of text is divided into twenty chapters, touching on all phases of the subject.

Das Skizzieren von Maschinenteilen in Perspektive. By Carl Volk. 37 pages, 6 by 9 inches. 68 illustrations. Published by Julius Springer, 3 Monbijouplatz, Berlin N., Germany. Price, 40 cents.

As the name implies, it is a text-book on methods of making perspective drawings. Although printed in the German language, it is so profusely illustrated throughout that even to one unfamiliar with the language the book is very instructive. Considering first very simple rudimentary sketches, the principles and methods are gradually developed until complex mechanisms such as are met in daily drafting-room practice, are taken up, and explained step by step.

Spontaneous Combustion of Coal. By S. W. Parr and F. W. Kressmann. 87 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

This bulletin describes a series of experiments directed toward the determination of the fundamental causes underlying the spontaneous combustion of coal. These causes may be summarized as follows: (1) external sources of heat, such as contact with steam pipes, hot walls, and the impact of large masses in the process of unloading, height of piles, etc.; (2) fineness of division; (3) moisture; (4) activity of oxidizable compounds, such as iron pyrites. An historical review of the literature upon the spontaneous combustion of coal is given in the appendix.

La Compagnie des Chemins de Fer de Paris a Lyon et a la Mediterranée a l'Exposition Internationale de Turin, 1911. 26 pages, 8 by 12 inches. Illustrated, 11 plates.

It is very rarely that such a thoroughly gotten up book as this one, describing the rolling stock exhibited at Turin by the Paris to Lyon and the Mediterranean Railway Company, is ever published by any railway. Being in French will make it a closed book to many, which is unfortunate, so valuable is it in setting forth the best practice in French (and consequently continental European) rolling stock construction. The profuse illustrations give a good idea of the degree of comfort made possible by some of the beautiful designs of passenger cars. The eleven plates referred to illustrate locomotives and their characteristics.

Inventor's Pocket Library. 4 by 9 inches. Ten pamphlets in the set, varying from four to six pages each. Published by the Engineer Searching Co., 1403-5 New York Ave., N.W., Washington, D. C.

This series of pamphlets, dedicated to the brotherhood of inventors, contains ten talks on patent subjects for young inventors, warning them of the various pitfalls, and instructing them in the fundamentals of patent law. The titles of the ten pamphlets are: The Language of Two Letters; Hints, Tips and Don'ts for Inventors; The "Brotherhood" Protective Caveat; Inventor's Catechism; Inventor's Dictionary; American Wastes the Inventor's Opportunity; Why Success or Failure in Invention?; The Superstition of Secrecy; Educational and Protective Value of Sketching; and Engineer or Lawyer Searching.

Practical Instructor and Reference Book for Locomotive Firemen and Engineers. By Chas. F. Lockhart. 362 pages, 5 by 7 inches. 88 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $1.50.

The incentive for writing this book lies in the realization by the author that the locomotive engineer who does not combine technical knowledge with that gained from practice is fast giving way to the more progressive type. With that object in view, the author has endeavored to combine technical knowledge with practical experience in such a way as to make the book thoroughly intelligible to all engineers and firemen; the author has made good service of his practical knowledge in so doing. Throughout the idea of simplicity seems to have been kept well to the fore, and in order that it might be useful for ready reference as well as for a test, it is subdivided to such an extent that the desired points can be readily gotten at. There are six main parts as follows: The Fireman's Duties; General Description of the Locomotive, Its Construction and Operation; Locomotive Breakdowns and Their Remedies; Air Brakes; Extracts from Standard Rules, and Questions for Examination.

Principles of Industrial Engineering. By Charles B. Going. 174 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., New York. Price, $2.

In the beginning of manufacturing when the number of individuals employed in any one shop, mill or factory was comparatively small, the science of management was without shape or form, although probably every manager worked in harmony with certain principles, if he was successful. These principles being largely an expression of personality, were accepted as attributes of men rather than something capable of classification and definition. The past quarter century of unparalleled industrial development has been marked by the organization and formulation of certain principles of management applicable to large and small industries. This book in review is composed principally of the text of lectures delivered by the author before the senior students in mechanical engineering, Columbia University, modified somewhat to suit non-technical readers. The contents by chapters are as follows: "The Origin of the Industrial System"; "Reflex Influences of the Industrial System"; "Principles of Industrial Organization"; "Forms of Industrial Ownership"; "The Nature of Expense"; "Distribution of Expense"; "Labor—The Primary Wage System"; "Labor—Philosophies of Management"; "Materials."

CATALOGUES AND CIRCULARS

AUTOMOBILE CLUB OF AMERICA, 54th and 55th Sts., west of Broadway, New York. Bulletin of the facilities for testing motors and automobiles with rules for scientific tests.

BLASHILL & GRAY, London, Canada. Catalogue of B and G rotary single strand barb wire machine (see MACHINERY, January, 1911, for description of the principle of operation).

CROCKER-WHEELER CO., Ampere, N. J. Circular of Remek transformers, describing the general method of construction, and giving data of interest to electrical engineers and users.

VULCAN SOOT CLEANER CO., Pittsburg, Pa. Catalogue of the "Vulcan" soot cleaner for removing soot and ashes from the heating surfaces of boilers, and thus increasing boiler efficiency.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4819 on alternating-current switchboard panels with oil switches on panels for three-phase, three-wire circuits of 480 and 600 volts, 25 to 60 cycles.

UNITED ENGINEERING & FOUNDRY CO., Pittsburg, Pa. Catalogue of high-speed forging presses of the steam-hydraulic intensifier type, built for all classes of forging, shearing or pressing, 100 tons to 12,000 tons capacity, all with single lever control.

HESS-BRIGHT MFG. CO., 21st St. and Fairmount Ave., Philadelphia, Pa. Catalogue of ball bearings for woodworking machinery, illustrated with examples of woodworking machines equipped with Hess-Bright annular and thrust ball bearings.

NATIONAL CARBON CO., Cleveland, Ohio. Bulletin on the "Practical Operation of Arc Lamps," containing also practical electrical data useful to linemen, electricians, electrical engineers, etc. The bulletin contains 76 pages, and will be sent free on request.

GISHOLT MACHINE CO., Madison, Wis. Leaflet briefly describing the growth of the company's business and giving the reason for the name "Gisholt." "Gisholt" is the name of the boyhood home in Norway of the founder of the business, Mr. John A. Johnson.

CHAMBERSBURG ENGINEERING CO., Chambersburg, Pa., builder of steam and hydraulic forging, bending and flanging tools, calendar 18 by 26½ inches, June, 1911, to May, 1912, inclusive. The calendar illustrates the double and single column types of steam hammers.

CENTURY MFG. CO., Cleveland, Ohio. Circular of the Century adjustable steel drafting table made in thirteen sizes, ranging in price from \$6.50 to \$54. For the smaller sizes the tables are made with basswood tops, and for the larger sizes with Michigan white pine tops.

MARIS BROS., 56th St. and Gray's Ave., Philadelphia, Pa. Catalogue of I-beam trolleys, plain and geared types. The trolleys are made of steel, except the wheels, which are of cast iron with chilled treads., for 4-inch to 18-inch I-beams and from ¼ to 10 tons capacities.

ARMSTRONG BROS. TOOL CO., 313 N. Francisco Ave., Chicago, Ill. Circular of the Armstrong drop-forged steel lathe dogs and clamps. The lathe dogs are made with single screw up to 6 inches capacity, and with two screws up to 8 inches capacity. The clamps are made up to 12 inches capacity.

PULSOMETER STEAM PUMP CO., 17 Battery Place, New York. Catalogue No. 17 on the "pulsometer," a steam pump without pistons or rotors. The pulsometer is largely used by contractors for draining trenches, excavation of cellars, sewers, etc., being unaffected by the grit or gravel that ruin a piston pump.

OTTO GAS ENGINE WORKS, 33rd and Walnut Sts., Philadelphia, Pa. Bulletin No. 34, illustrating and describing the Otto gasoline electric tool car for railway maintenance-of-way work. It is used for conveying men and tools to points along the track and for supplying the necessary power to operate electric track tools.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Bulletin illustrating large office buildings in New York City equipped with Cutler-Hammer apparatus. The bulletin includes a large scale map of Manhattan Island, incidentally showing the locations of the New York plant of the Cutler-Hammer Mfg. Co., and its up- and down-town offices.

HESS-BRIGHT MFG. CO., 21st St. and Fairmount Ave., Philadelphia, Pa. Catalogue of ball bearings for flour and feed milling machinery of the annular and thrust bearing types. It is claimed that the use of ball bearings and milling machinery greatly reduces the power consumption and eliminates the risk of fires incident to hot bearings.

CHICAGO AUTOMATIC SCREW MACHINE CO., Oakley Ave., Kinzie St. and C. & N. W. tracks, Chicago, Ill. General catalogue of automatic screw machines built in five styles and capacity from ¾ to 2 inches, inclusive; also Chicago semi-automatic threader, metal saw; spring chucks and feeders and automatic screw machine equipment in general.

HESS MACHINE WORKS, 25th & Callowhill Sts., Philadelphia, Pa. Circulars of file grinding and file cutting machinery. The file cutting machines are furnished in seven sizes, having capacities from the largest to the smallest files. The file grinding machine is designed for grinding file blanks preliminary to the cutting operation; it is built in two sizes, having capacities from 18-inch to 3-inch files.

SCHUCHARDT & SCHUTTE, Cedar and West Sts., New York City. Circular of a hand tachometer of improved form, made in seven styles ranging in price from \$25 to \$38, and registering 300 to 12,000 revolutions per minute. The "S & S" tachometers indicate not only the number of revolutions of shafts and spindles, but by using the measuring disk, the peripheral speed of pulleys or belt speeds can be read directly.

VANADIUM SALES CO. OF AMERICA, Frick Bldg., Pittsburg, Pa. Special number of *American Vanadium Facts*—convention issue for the American Foundrymen's Association held in Pittsburg in May. The number is devoted to vanadium in cast iron, vanadium steel castings, and vanadium in bearing metals; it contains photographs of special vanadium steel castings for locomotive work, locks of the Panama Canal, etc.

UNION TWIST DRILL CO., Athol, Mass. Catalogue No. 100, on milling and high-power cutters of high-speed steel. The Union Twist Drill Co. is manufacturing the new line of milling cutters developed by the Cincinnati Milling Machine Co. under the direction of its chief engineer, A. L. DeLeeuw (see MACHINERY, April, 1911, for abstract of paper by A. L. DeLeeuw, on these cutters and their characteristics read before the Spring 1911 meeting of the American Society of Mechanical Engineers).

BOSTON GEAR WORKS, Norfolk Downs, Mass. Catalogue E-4 containing directions for ordering gears; design of standard steel gears; lists of cut steel spur gears from 16 to 6 pitch, inclusive; cut cast-iron spur gears from 20 pitch to 4 pitch, inclusive; steel racks with generated teeth; finished brass spur gears; brass racks; cut brass internal gears; steel miter and bevel gears; cast-iron miter and bevel gears; brass miter and bevel gears; steel worms and cast-iron worm-gears; iron, brass and steel helical gears; sprocket wheels and chains; universal joints, etc.

GREENLEE BROS. & CO., Rockford, Ill. Sectional catalogue of railway car shop and special woodworking machinery, comprising chisel mortisers; horizontal and vertical car borers; multiple spindle and gang borers; power feed and power self-feed rip saw benches; single and double automatic horizontal cut-off saws; variety, universal and cabinet saw benches; light and heavy, single and double tenoners, gainers and vertical saws; jointers, variety woodworkers, and sash and door machines; stickers and outside molders, mine timber machines; cutter heads and specialties; chisel bits, augers and other tools.

GENERAL FIRE EXTINGUISHER CO., 1 Liberty St., New York, has issued a special bulletin on the Asch Bldg. in New York, where nearly one hundred and fifty persons lost their lives. The bulletin illustrates the horrors of the fire and emphasizes the importance of equipping manufacturing plants containing highly inflammable materials with automatic sprinklers. Had the Triangle Shirtwaist Co.'s factory in the Asch Bldg. been equipped with automatic sprinklers, the fire undoubtedly would have been confined to a very small blaze that could have been quickly extinguished without the panic and the terrible resulting loss of life.

FOOS GAS ENGINE CO., Springfield, Ohio, has collected data for a bulletin No. 92 on the relative economy of internal combustion engines, operating on petroleum and distillates. A 23-horsepower engine working at full load on kerosene at 5 cents a gallon shows a fuel cost of \$1.55 for a ten-hour day. A gasoline engine under the most favorable conditions would use 31¼ gallons of fuel, which at 12 cents per gallon would cost \$3.75. The total saving for 300 working days is \$660 in favor of the oil engine. Inasmuch as kerosene as low as 4 cents a gallon may be obtained in many places, and oils are available at 2½ cents, the advantage is even greater than indicated in the foregoing.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis. Attractive bulletin illustrating the plant and products of the company, which is one of the leading concerns in Milwaukee. The plant occupies a tract of twenty acres and includes a main factory building 414.4 by 360 feet, comprising the girder and erecting shops, trolley assembling, machine shops, electrical department, castings storage, stock-rooms, templet and carpenter shops. Other buildings are the storage shed, foundry, pattern-shop, power house and office building. The products illustrated comprise: traveling cranes; charging machines; electric hoists; telpher hoists, switches, turntables and crossovers for monorail system; motors; controllers; I-beam trolleys; horizontal, drilling and boring machines; grab buckets, etc.

TRADE NOTES

H. W. JOHNS-MANVILLE CO., 100 William St., New York, recently acquired the sole American rights to the well-known English packing "Sea" rings.

FORT WAYNE ELECTRIC WORKS, was merged with the General Electric Co. June 1, and will hereafter be known as Fort Wayne Electric Works of the General Electric Co.

GREENLEE BROS. & CO., Rockford, Ill., have transferred their general machinery sales office for car shops and special woodworking machinery from Chicago, Ill., to Rockford, Ill.

CARPENTER-KERLIN GEAR & MACHINE CO., maker of cut gears, has changed its corporate name to Carpenter-Tew Gear Co., and has removed its factory and office to Bush Terminal Bldg., Factory No. 5, Brooklyn, N. Y.

L. S. STARRETT CO., Athol, Mass., announces that its New York store is now permanently located in new and larger quarters at 150 Chambers St., where a complete stock of fine mechanical tools is in charge of Mr. L. G. Kuhn, manager.

BILLINGS & SPENCER CO., Hartford, Conn., has begun the construction of a 40- by 113-foot, three-story and basement addition to its storehouse and shipping department. A new pickling house measuring 20 by 30 feet, and a heat-treatment or annealing room, 35 by 60 feet, are also being added.

SPRAGUE ELECTRIC CO., 527 West 34th St., New York, was merged with the General Electric Co., Schenectady, N. Y., June 1. The business will be conducted under the name of Sprague Electric Co. Works of the General Electric Co., and under the same organization as heretofore, with Mr. D. C. Durland general manager.

AUTOMOBILE CLUB OF AMERICA, New York, will conduct a competitive test of aeronautical motors. The winner will be awarded a cash prize of \$1000. Entry blank and rules for the test can be obtained from the Testing Laboratory, The Automobile Club of America, 54th and 55th Sts., West of Broadway, New York.

ERIE CITY IRON WORKS, Erie, Pa., has completed its new stack and tank shop building, 300 feet by 100 feet, which is up to date in every respect, both as to the building and equipment. The company is now prepared to quote prices on all sizes of tanks, including air-pressure tanks, water pressure tanks, sugar tanks, drip tanks, ordinary light steel tanks, etc.

THOMAS D. ANDREWS, instructor of engineering, School of Mines and Industries, Bendigo, Victoria, Australia, requests manufacturers of machine tools, mining machinery, pumping machinery, steam and gasoline engines, cranes, hoists, steel work, etc., to send their catalogues for filing in the school library, where they will be referred to by students studying engineering.

ANDERSON & TAYLER, Ford Bldg., Detroit, Mich., is a partnership recently formed by Edward L. Anderson, industrial engineer with office formerly in the Newberry Bldg., and Theron C. Tayler, mechanical engineer, located in the Ford Bldg. The partners will maintain a testing laboratory in the Newberry Bldg., and their work will consist of examinations, tests and reports on economy, efficiency and capacity of power and industrial plants and accessories.

TATE, JONES & CO., INC., Empire Bldg., Pittsburg, Pa., exhibited an interesting demonstration car at the Atlantic City convention of the American Railway Master Mechanics' and Master Car Builders' associations. The car contains an upright boiler arranged for using oil fuel and a large oil-fired forging furnace, designed by Tate, Jones & Co., Inc., and a hydraulic forge press built by the United Engineering & Foundry Co., of Pittsburg. The outfit was in full operation and attracted many railway men interested in economical and efficient blacksmith shop equipment.

OTTO GAS ENGINE WORKS, Philadelphia, Pa., has appointed Mr. M. A. Johnson, 537 S. Dearborn St., Chicago, Ill., its representative in the Western territory. Mr. Johnson's territory comprises Illinois, southern Michigan and Wisconsin, eastern Iowa, eastern Missouri and part of Indiana. A complete stock of Otto engines and repairs is carried at Chicago permitting of prompt service to the trade. Mr. Johnson was for a number of years sales manager with the Fairbanks, Morse Co., of Chicago, covering the central West. Prior to that connection he was with the Champion Harvester Co.

FICHTEL & SACHS, Schweinfurt, Germany, makers of the "F. & S." annular ball bearings, and whose American representative is the J. S. Bretz Co., have begun an action against the R. I. V. Co., the importers of the "R. I. V." bearing, for infringement of the side entrance slot filling patents which they own. The bill of complaint alleges infringement of both the Kouns patent No. 537,689, and the Blinn patent No. 818,734, for improvements in ball bearings. The value of these patents, and others used in combination with them,